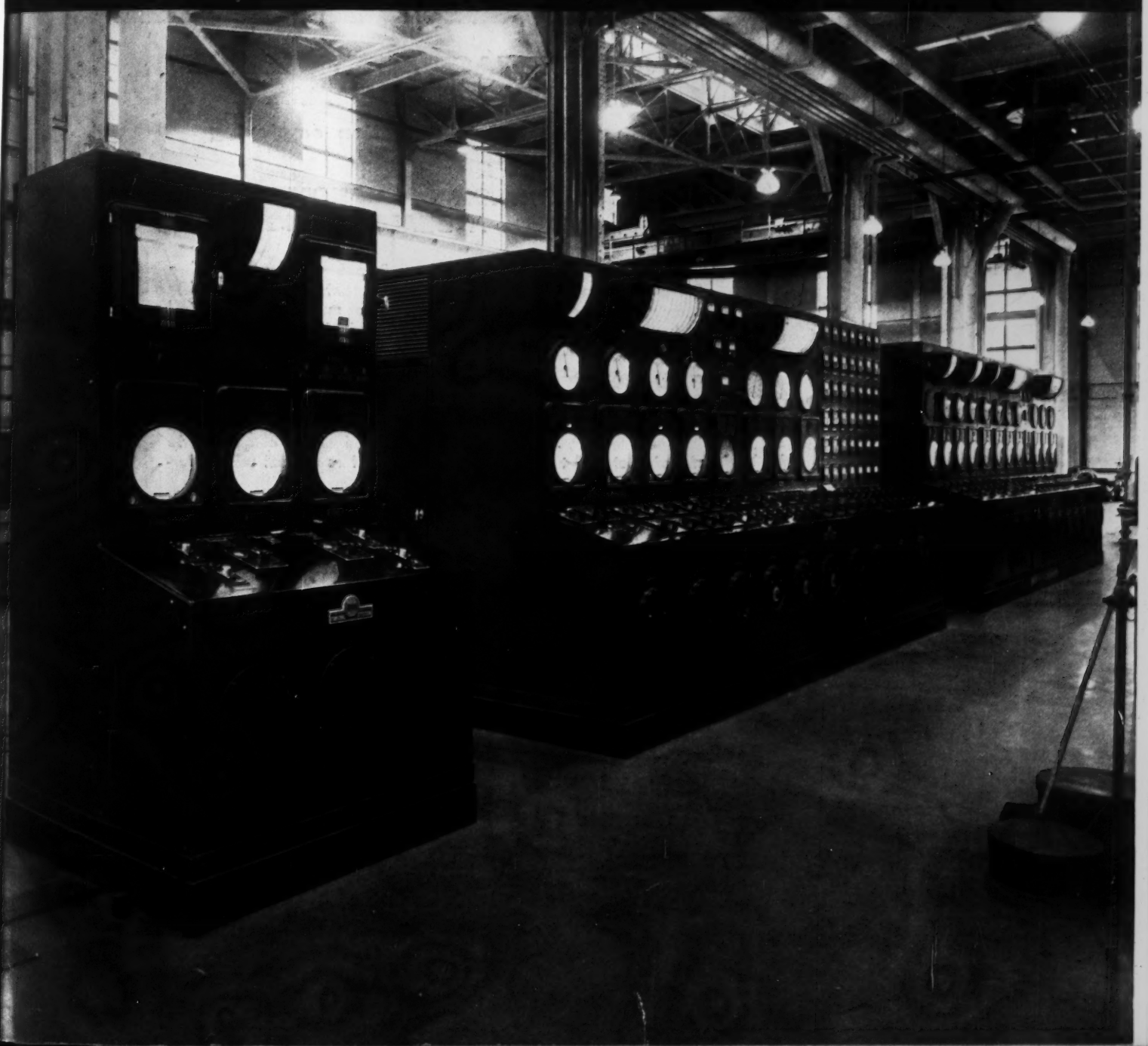
Vol. 19 OCTOBER 1946 No. 10

Instruments

THE MAGAZINE OF Measurement and Control



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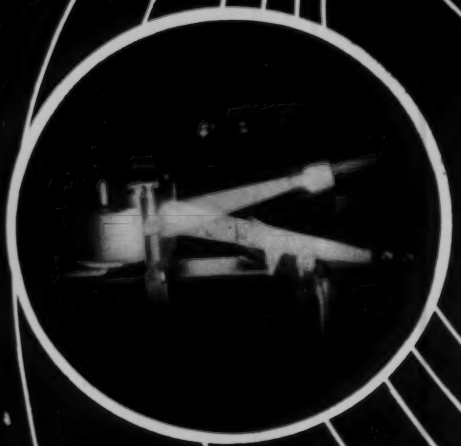

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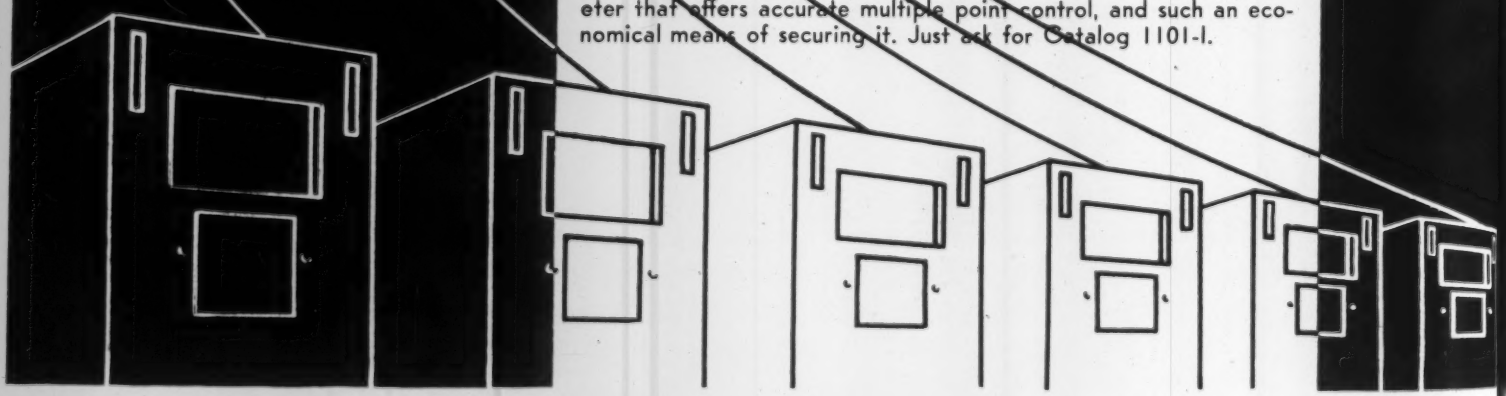

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EDITORIAL By M. F. BEHAR

Culmination and Commencement

"BIGGER and better than I expected." That was said by four out of five of the hundreds of men with whom we conversed during the "Instrumentation for Tomorrow" Conference and Exhibit which has just been held in Pittsburgh under the auspices of the Instrument Society of America. The remaining 20% expressed similar views. There was not a single exception. In some instances—when we had time—we led the conversation from the general to the specific. Most men said they could not think of anything requiring improvement and their only regret was the impossibility of being in two places at the same time on the mornings or afternoons when there were simultaneous sessions.*

We cannot recall a single conversation in which any comment on the Conference and Exhibit *as a whole* was less than whole-heartedly favorable. The expression "bigger and better" recurred often because it is the customary locution and our own impression is that most of the men we interviewed really meant: "Everything is much BETTER than I expected—and this large attendance is just what I did expect." (The attendance was nearly 5000.)

It is proper, therefore, to declare that we could accurately summarize this editorial in one word—the word SUCCESS. Our heart is so full that we wish we had hundreds of pages at our disposal!

And indeed it would take about a thousand pages of *Instruments* to present a detailed report of this historic Conference and Exhibit. We shall be specific:

1. EXHIBIT.—Even a dry factual report of the Exhibit —including brief small-print descriptions of *only ten percent* of the three or four thousand different products displayed by the 102 exhibitors—would take 300 or 400 pages (600 or 800 pages if most of the descriptions were illustrated the way they are in our "New Instruments" Department). On the next page, you who were not there will find four photographs which may convey some idea of the general impression gained by a visitor on his first walk through the three rooms, before he entered various booths.

2. SESSIONS.—As for the Conference sessions, each would deserve about fifteen or twenty pages—about three-quarters for the papers and one-quarter for the ensuing discussions —and the Conference comprised a total of thirty-two sessions:

	Sessions	*Papers*
ISA: General	14	33
Educational	12	12
American Society of Mechanical Engineers	3	12
Joint ISA-ASME	1	2
Physical Society of Pittsburgh	1	3
Naval Ordnance	1	4
Totals	32	66

In this connection we recommend that you refer to the sixteen-page Official Program which was bound in the middle of last month's issue of *Instruments*, because the abstracts of technical papers are, on the whole, excellent. By the way, two technical papers were added after the program was printed, so please add on Page 4: Tuesday morning, "Use of Instruments in Quality Control Work" by Joseph Manuele, Director of Quality Control, Westinghouse Electric Corp. Tuesday afternoon, "On the Relation of Instrumentation to Quality Control" by Colonel Leslie E. Simon, Ordnance Dep't, U.S.A. We have already edited both these papers into *Instruments* articles and they will appear in an early issue.

3. COMMITTEE MEETINGS.—Various committees of the ISA and of other societies held well-attended meetings productive of important results. There were fifteen to seventeen such meetings. (We can't find anyone who kept track.) Most of the important results, however, will no doubt appear as mimeographed minutes or formal reports circulated only among the committeemen. An adequate report of this historic Conference should include perhaps thirty pages on committee accomplishments.

4. DINNERS, ETC.—There were twelve scheduled meal gatherings and perhaps ten hastily-arranged group luncheons and dinners. At the ASME's big dinner Monday evening the toastmaster was none other than R. J. S. Pigott, Past President of the American Society for Measurement and Control (which last year was merged into the ISA) and the speakers were ASME President D. R. Yarnall and Admiral Luis DeFlorez. It was semi-formal as befits a 64-year-old society. In contrast, the young ISA held a *very informal* buffet dinner on Wednesday evening followed by a vaudeville show including both professional entertainers and skits put on by the Philadelphia and Pittsburgh Sections.

5. STATISTICS, ETC.—If only for historical purposes, it would be desirable to devote many pages to classifications and analyses of the attendance, of the topics discussed, of the products exhibited, etc., etc. at this FIRST National Instrument Conference and Exhibit. We may take two or three lines to report that the majority of the partic pants and visitors were *Instruments* subscribers. Most of these came BECAUSE of the advance publicity in the columns of this magazine. The two visitors from Switzerland had already planned an American trip but they included Pittsburgh in their itinerary because they read our July editorial and for no other reason. We may also mention that, thanks to the participation of the Physical Society of Pittsburgh, this Conference on "Instrumentation for TOMORROW" included a session entirely devoted to instruments for atomic energy production and utilization.

6. BOUQUETS.—We wish we had many pages also for reporting the unselfish efforts of the scores of workers. No one will be jealous. however, when we award the choicest orchids to the Educational Committee:

Genl Chmn: B. R. Teare (Carnegie Tech).

ELECTRICAL INSTRUMENTS. L. F. Parachini (Weston) *Chmn*, F. C. Ashe (Carnegie Tech), H. S. Day (General Electric), F. S. Adkins (Westinghouse).

INDUSTRIAL INSTRUMENTS. M. B. Hall (Foxboro) *Chmn*, W. G. Baker (Monsanto), C. B. Cochran (Westvaco Chlorine Products), H. E. Ferguson (People's Gas, Chicago), J. J. Gordon (Tennessee Eastman), G. E. Heller (Taylor Instr.), J. G. Kirkpatrick (Koppers), C. E. Mason (Bristol), J. C. Mouzon (Brown Instr.), D. C. Saylor (Carnegie Tech).

GAGES. Rush Bowman (Precisioneering) *Chmn*, Lt.-Col. W. J. Darmody (U. S. Army Ordnance), H. E. Goffman (Westinghouse).

7. SIGNIFICANCE.—This was the glorious culmination of twenty-two years of advancing the idea that Instrumentation is a distinct branch of science and technology—an idea which met ridicule at first.* It was also like a college Commencement Day signalizing the definite emergence, to the forefront of our American industrial civilization, of Instrument Men—not only those who are dues-paying members of the ISA and of other societies that recognize Instrumentation as a distinct field, but ALL Instrument Men. The predictions we made in our July and September editorials—and in others long ago—will come true! A New England visitor, who has subscribed to *Instruments* since 1932, gave us the best idea when he urged us to reprint once more the passage first printed on this page in June 1933, just after we became your editor:

All men who invent, design, build, sell, specify, apply, install, service and maintain measuring instruments, gages, meters and automatic-control equipment belong to one fraternity . . .

Yes, "Instrumentation for Tomorrow" was so successful that this same theme should be used for the 1947 Conference and Exhibit in Chicago . . . and for the subsequent ones . . . —MFB

*In a sense, this was a compliment—a recognition of the interest-value of each of two or more sessions held at the same time. The subjects, of course, were always widely different.

*See references to the groundwork in editorials of (e.g.) Dec. '34, July '38, Dec. '38, Aug. '39, Dec. '39, June '40, Dec. '40, May '41, Feb. '42, April '44, Dec. '44.

AT THE I.S.A. INSTRUMENT EXPOSITION

Top: The two aisles in the Grand Ballroom.

Left: Silver Room.

Right: One aisle in the Urban Room.

Process Unit Control Instruments, Their INSTALLATION and INITIAL OPERATION

By HARRY F. MOORE, Esso Engineering Dep't, Standard Oil Development Co., Elizabeth, N. J.

CONSTRUCTION of a large petroleum refinery process unit such as a catalytic cracker, alkylation plant, polymerization unit or butadiene unit, is heavy construction. Quite logically the primary concern of the construction crew begins and centers on those items which are the biggest problems during the actual construction period, and those items requiring the greatest number of men and man-hours. Heavy foundations, tall towers, miles of piping, and large furnaces are the items which loom large to the construction man.

Construction Practice, Heavy Items

In building the items enumerated the builders utilize the well-known and long-established trades of carpenter, mason, pipe-fitter, boilermaker, machinist and electrician. The welder is a relative newcomer, but he is well established and the need for his service is recognized. On these "tonnage items" (foundations, towers, etc.) the construction industry knows exactly what the function of each craft is and the percentage of completion is usually measurable in tons, or board feet, or some similar unit, and is quite apparent when one looks at the job. With this heavy type of construction item, when the concrete or steel or pipe is in place, it is "installed" and "ready for operation."

When the equipment installation stage is reached there is a different tempo. Heat exchangers and other shell and tube units are handled somewhat as a tonnage item. They do, however, require more care in handling and thus they are given somewhat more attention. The centrifugal pumps are set on their foundations, grouted in, and then the machinists take over for the lining up of pump and driver, filling and checking lubrication devices, packing, and a short trial run. Here a greater degree of skill and attention is needed, but the need is obvious to even the water boy on the job and no one ever suggests "saving money" by eliminating the servicing, or having the machinist replaced by a less skilled person. With equipment such as large gas-engine-driven compressors, turbogenerators and turboblowers, a further step is taken. With such equipment it is standard practice to have the manufacturer furnish a qualified man for erecting the equipment, preparing it for service and, generally, to be present during the break-in period and initial operation. This procedure is easy for the construction man to understand and to justify. It protects the manufacturer by preventing those mistakes which a general-purpose machinist might make because of lack of specialized knowledge of a complex mechanism. Such equipment is expensive and of primary importance to the operation, thus the specialized erector protects the construction people and the refiner from the possibility of one small error causing the entire process unit to be kept out of service beyond the normal construction time.

Installation of Measurement and Control Equipment

When the measurement and control instruments and equipment are installed, one would offhand expect that they would be given special attention. Although not delicate in the usual sense, they are certainly not as rugged as a heat exchanger or a centrifugal pump, and the manner of their functioning is quite mysterious to the layman. But there is no recognized craft to take them over and tend to their individual needs, such as there is with the pumps. They are not large enough, expensive enough, nor individually important enough to the operation of the unit to have the compressor or turbogenerator type of care lavished on them.

The construction drawings show a host of relatively small items mounted on control house panels and on pedestals scattered throughout the unit. They are connected to the process equipment and process lines with ½" and ¾" pipe. They are connected to one another and to the control valves with miles of ¼" or ⅜" O.D. tubing. Quite naturally, therefore, a pipe-fitter is assigned the job and, as process lines are "installed" and "ready to operate" when they are connected together and fastened to the supports, the pipe-fitter's job is considered finished when the instrument items are mounted and the piping and tubing connected. The electrician runs the necessary wiring, and then, as far as the builder can see, his responsibilities are discharged and the process control equipment is ready for operation.

How the Construction Methods Work Out

The construction industry methods outlined above usually give satisfactory results to the builder and the operator as far as the "tonnage items" are concerned and also for the equipment items of exchangers, pumps, compressors and turboblowers. With process control instrumentation, owing to the lack of proper personnel, the system fails miserably. Although the rumblings of discontent are beginning to reach their ears, the construction industry men do not yet clearly understand why.

The essential needs of proper installation and preparation for service of the measurement and control devices are so fundamentally and so widely different, and so abstract to "tonnage" men, that it is ordinarily impossible to explain to their satisfaction why anything other than the electrician and pipe-fitter are needed on the job.

Because of this general situation, the installation, preparation for service, and initial operation of the measurement and control instrumentation receive insufficient attention.

An Example of Satisfactory Methods

On a recently-constructed, unusually large and important process unit that had the measurement and control equipment properly handled by qualified instrument technicians and mechanics, a record was kept of the time spent by these operating instrument people. This time totaled 5300 man-hours, all in addition to that spent by the builder's pipe-fitters and electricians in bolting down, piping and wiring. It was the time necessary to bridge the gap between "construction" and "operation." The time record was made in sufficient detail to segregate the costs for the various classes of instruments and also subdivided into the type of job performed within each class. It is thought that a perusal of the man-hour requirements of the jobs and consideration of the actual duties and functions indicated by the job headings should dissipate the vague, intangible character that such activities have in the minds of construction people.

Table I was prepared from the time record referred to. A few liberties were taken with the verbatim record, in order to reduce the number of subdivisions. Each item is further divided between shop and field. In making this division, time was listed in the shop column when the job was performed by shop-assigned personnel, whether the

Presented at the first Annual Conference of the Instrument Society of America, William Penn Hotel, Pittsburgh, Penna., Sept. 16-20, 1946.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.

work actually took place in shop or in field. Thus, some items show only shop time when an appreciable amount of the time was spent in the field, and vice versa.

Field Calibration Requirements

A description of the various jobs totaled for Item No. 1 of the table would be:

(a) Removal of flowmeters for shop overhaul
(b) Checking flow transmitters, locally-mounted flow recorders and indicators
(c) Changing range tubes on flowmeters
(d) Making one float
(e) Alteration to locally-made range tube
(f) Cutting 24 flowmeter door glasses
(g) Checking calibrating and correlating all types of flowmeters, and changing range tubes as required.

When such a detailed description is examined, the necessity of having someone other than a pipe-fitter and electrician on the job becomes obvious. Referring to (*a*), the pipe-fitter could remove a flowmeter for overhaul, but who would tell him it needs overhauling, and what shop does he take it to? With (*b*) the difficulty is even more profound. It is not obvious to many people why such an item as a manometer or a transmitter needs to be checked in the field when it has been checked and certified at the factory. The answer is that although it is not in the watch class as to precision and fragility, it cannot be depended on to stand the joltings of a freight car, the many handlings of LCL freight, the usual rough handling or mishandling of a construction job, and perhaps outside storage for months, and still be within industrial tolerance limits. When equipment leaves the factory, after calibration, it can be depended on to be within the tolerance established by the specification or guarantee. After the shipping and construction treatment outlined above, the instrument will be out of calibration, but if not actually damaged should be "inside the barn door" on the first field check. Modern equipment has the adjustments so that it can be field-recalibrated. Here the need for someone that understands the equipment needs no pointing out, and the ugly suspicion may even be planted that something beyond a mechanic's classification may shortly be encountered.

Omitting comment on the other subdivisions of Item 1 of Table I, and going on to Item 2, field experience has established that pneumatic transmission system receivers require a check and calibration. The need for this has the same basis as in the case of the manometers and transmitters.

Need for Personnel with Knowledge of Instrument Equipment

Item 3 of Table I covers the inspection, repair and alteration of orifices, both measurement and restriction types. An instrument mechanic may or may not know that differences in the sharp edge of an orifice which are not visible to the naked eye can cause errors of 0.5%, but in any event he will not be guilty of stringing a batch of plates over a piece of 2" pipe and having his helpers jauntily march off with the pipe on their shoulders. Pipe-fitters have been and will be guilty of such actions.

The field portion of time charged to Item 4 is accounted for by one job order reading "Check and Adjust Control Valves." The shop portion originated from three job orders reading:

(a) Alteration to control valves and preparation for service.
(b) Repairs to butterfly valve.
(c) Repair ½" valve.

Attempting to state the order of importance of the three portions of an automatic controller installation (primary element, instrument, and control valve) would be somewhat like picking the most important leg of a three-legged stool. All are essential. Therefore, although "most important" should not be used to describe the control-valve portion, "essential" may be used. In addition, it can be said that of the three items, the control valve was the orphan for many years and its importance has been widely acknowledged only in recent years. The acknowledgment, in instrument circles, takes the form of checking the valves for the following and making adjustments and corrections as needed.

1. *Friction.* Some call this "hysteresis" (a highbrow term for stuffing-box friction). It is always present, and may amount to as much as 2 to 4 lbs./in.^{2} on the diaphragm with deformed, hard, or compacted packing. It can rarely be reduced below 0.25 lb./in.^{2} on the diaphragm. For good control results it may be necessary, on finding a high friction value, to repack the stuffing-box, dismantle to remove rough spots or to correct poor machining, straighten the stem, or correct some other of the many items that can and do cause high friction or jumpy operation.

2. *Travel.* The valve will have rated capacity only when the plug is raised the full amount of the designed travel off the seats. With the 50-to-1 rangeability equal-percentage valve, this point has special significance, as the last 10% of lift develops 32% of the capacity, and the last 5% of lift develops 17% of capacity.

3. *Spring range.* A valve designed for a nominal 2 to 14 lbs./in.^{2} spring range will work equally well if adjusted to 1-13 or 3-15 lb./in.^{2}. However, for flexibility in relocating valves, and for the instrument man to know what a valve is doing by glancing at the diaphragm pressure, all must have the same spring range. There is no good reason why they cannot all have the same spring range within close tolerances, and adjusting them to the same range pays off later on in flexibility when changing valve location, and in giving control-room operators and instrument men confidence that the output air pressures of the controllers are a correct measure of valve position and thus process load.

As implied in (*b*) and (*c*), control valves are among the items which can be seriously damaged during the construction period. When this happens, repairs are in order. It could be successfully argued that a machine shop can perform any function necessary to make most if not all control-valve repairs. This is true, but only after someone who fully understands the operation of the valve points out specifically what must be done, and to what tolerances. With reference to this necessity, and returning to a simple device such as an orifice plate, it is really remarkable how difficult it is to get an experienced and qualified machine operator to perform the relatively simple operation of machining the upstream edge of the orifice to obtain the essential feature of a "sharp, square edge." Similar (although less easily understood) troubles are experienced with control valves. Precision and accuracy do not come easily or cheaply, even in the highly-regarded American industrial scene.

Item 5 in Table I is taken from a single job order, and appears to be comparable to other jobs already covered. It is quite different, however. Level measuring equipment on a petroleum refining unit must be responsive and a check of this point is required. Close calibration, which consumes much more time than checking does, is not necessary, and the expense of calibrating closer than 5% would not be justified. The level equipment on the process unit being studied was of the differential type, and the 92 hours charged to Item 5 was for the responsiveness and rough calibration check, the mercury filling

TABLE I

Item No.	Description	Man-hours Shop	Man-hours Field
1.	Flow manometers.—Check, calibrate, repair, range tube changes, correlation.	283	711
2.	Pneumatic receivers.—Check, calibrate.	11	153
3.	Orifices.—Measurement and restriction Inspect, repair, alter.	52	30
4.	Control valves.—Check, adjust, repair.	62	423
5.	Level instruments.—Check, calibrate.	92	...
6.	Pyrometers.—Check, calibrate. Couples.—Check installations.	22	199
7.	Controllers.—Alter, repair. Arrange by-pass panels.	56	...
8.	Piston positioners.—Repair construction damage, alter.	102	...
9.	Pressure gages.—Test, set.	34	...
10.	Boiler level alarms.—Design, build, install.	77	...
11.	Dial thermometers.—Survey for, install.	...	17
12.	Panel name plates.—Make, install.	97	...
13.	Emergency alarms and trips.—Final operation check.	...	17
14.	All instruments.—Final correlation check.	...	242
15.	All instruments.—Final operating test.	...	803
		888	2595
	Total shop and field		3483
16.	Office and engineering.—Inventory, records, instrument location and identification layouts, explanatory diagrams.		1834
	Total		5317

to set the operating range within the suppression limits, and the setting and adjusting of signal switches. To perform some of these operations requires that classic tool of the instrument shop, the water column. Construction pipe fitters wouldn't have such an item in the first place, and wouldn't know what it was for. The suppression construction, which gives desirable flexibility, is difficult to explain even to some instrument men.

Pyrometric Equipment

Item 6 in Table I covers activities for the pyrometric equipment, both instruments and thermocouples. Pyrometers used by the oil industry are of the potentiometer type. Therefore, the galvanometer needs no calibration, being used only to detect the circuit balance condition. This, coupled with the fact that the rebalancing mechanism is motor-driven, hence rugged for such a precise measuring device, leads to the conclusion that the factory calibration of the composite device might be retained despite shipment, in contrast to the transmitters and other items previously mentioned. This turns out to be correct, and thus a two- or three-point check, with no recalibration, usually is sufficient. The shop time of Item 6 consisted of the two jobs:

(a) Make iron-constantan couples, per instructions.
(b) Install slide wire in potentiometer recorder.

These job descriptions together with the small amount of time consumed (22 man-hours) attest to the relatively small amount of trouble with this class of equipment. Most of the field time of Item 6 was consumed by the approximately 200 thermocouples. Couples must be bottomed on the well, or responsiveness and accuracy of measurement will be impaired. The wells must be of correct length to insure sufficient immersion for the high temperature measurements (950 to 1100°F.) involved of which there were many. And, although it sounds a bit silly to say it, couples should not be connected to the lead wire with polarity reversed.

With such a large number of individual couples involved many mistakes of the type implied are encountered. The time to ferret them out is before any oil feed stock has entered the battery limits and not while the unit is going through the initial stages of operation.

Technical Grade Personnel Requirements

Items 7, 8 and 10 illustrate the need for personnel with qualifications beyond those of first-class instrument men. A technician would be a minimum need, and an instrument engineer would be kept busy. The major portion of time charged in Item 7 was spent in revising the air piping of four controllers so that a transfer of control from remote manual to automatic could be made without changing the air output pressure any measureable amount. Such an arrangement is commonplace today and is available as standard construction. A short two years ago, however, it was necessary to worry out the fundamentals and revamp the controllers in the field when it was learned that operation of an identical process unit in another location had made the need for such a manual-automatic transfer painfully evident.

Item 8 should never have happened. But something comparable is likely to take place on almost any job of large size, and thereby create an urgent need for experienced help. The process unit had six unusual valves of large size. They were operated by hydraulic pistons, which in turn were controlled by standard pneumatic controllers through a pneumatic-hydraulic piston positioner. The positioner was mounted on the cylinder, and the follow-up linkage connected, by the construction mechanics. Sometime before the positioners were "checked and adjusted" by the instrument people, the pistons were operated through their full travel for a construction purpose. The shipping stops in the positioner had not been removed, travel limits were not set, and in several cases roller style cam followers were off the cam. The result was that when the positioner covers were removed, it was much too close to being literally true that the contents consisted of a "bushel basket" of bent and broken parts. With the unit scheduled to start operations in four days, speed of repair was essential, as were several design changes to prevent certain failures recurring. Availability of (1) technicians, (2) excellent shop facilities, and (3) well-qualified shop men, solved the problem, with plenty of time for the normal checking and adjusting.

Item 10 became necessary when the suspicion was confirmed by test that the level indicating and alarm equipment furnished for the waste heat boilers ten stories up was inoperable under the prevailing conditions. This was during the war period, when long delivery time for any and all instruments was notorious, so the necessary equipment was made locally, using a few old instruments and a lot of ingenuity. This should be a clear example to show that the necessary work between construction and operation cannot be met with a few hours of free time by representatives (sometimes from the sales department) of various control instrument suppliers. Such a practice is sometimes advocated by construction people as a substitute for qualified instrument personnel.

Items 9 and 11 covering respectively pressure gage checks and a survey for, plus installation, of dial thermometers, have relatively few hours charged against them: 34 and 17. They are included for completeness, and they do add their bit to the complete picture. Gages are cheap, and anyone can be given the job of installing them. But when the unit starts, pressures assume a primary importance, and they therefore require a check. A goodly percentage will be found outside normal tolerance, which is readily understandable considering their low torque. The dial thermometer installations were desired by the operators for convenience in setting certain hand-adjusted valves, such as on the exit water line from a cooler, to minimize water consumption. They represent the "fielders' choice" type of item so common in the instrument field: some operators want them, others don't. Although a matter of opinion, it is frequently desirable to maintain the operators' confidence by giving in on such minor points.

Item 12 covers name-plate fabrication and installation. It is an example of a relatively unimportant item which can take an appreciable amount of time. About the same amount of time is needed, either to work out the names and place an order for them, or to work out the names and make them locally. Sometimes the names are simply stencil-painted directly on the board. In the case being studied, equipment was available in the Instrument Shop to engrave plastic blanks, so advantage was taken of it. This work can be considered as a misplaced construction item, and is not properly a part of the work of preparing the instrument equipment for service. The significance is that such misplaced items are by no means rare.

Item 13 has only 17 hours of field time charged against it. The importance of the item is considerably out of proportion to the amount of time recorded. The unit being studied had a rather elaborate system of emergency instruments in which measurements of selected process variables were made and in the event conditions departed from normal sufficiently to indicate a dangerous condition, it was necessary to operate certain valves automatically and also to actuate visible and audible alarm equipment. In most cases, the control point for the alarms was between the normal condition and the emergency operation condition. Malfunctioning of this system or any portion of it would have serious consequences in the operation of the unit. Failure of alarms or trips could cause a dangerous condition to go undetected, or could cause unnecessary alarms or partial shutdowns. Previously, on similar process units, it was indicated that a very close check was essential owing to the complication of the circuits involved in the emergency instrumentation. In addition to the 17 hours charged against this item, an unrecorded but appreciable amount of supervisor time was spent in analysis of the system and in arranging for the operation check.

Item 14 was the final correlation check of all instruments and required 242 man-hours. The word correlation needs to be explained, as it is not commonly used in the sense employed herein. It covers the check of the equipment on the unit against the construction drawings and specifications. The purpose of such a check is to insure, as examples, that a 50" manometer loca-

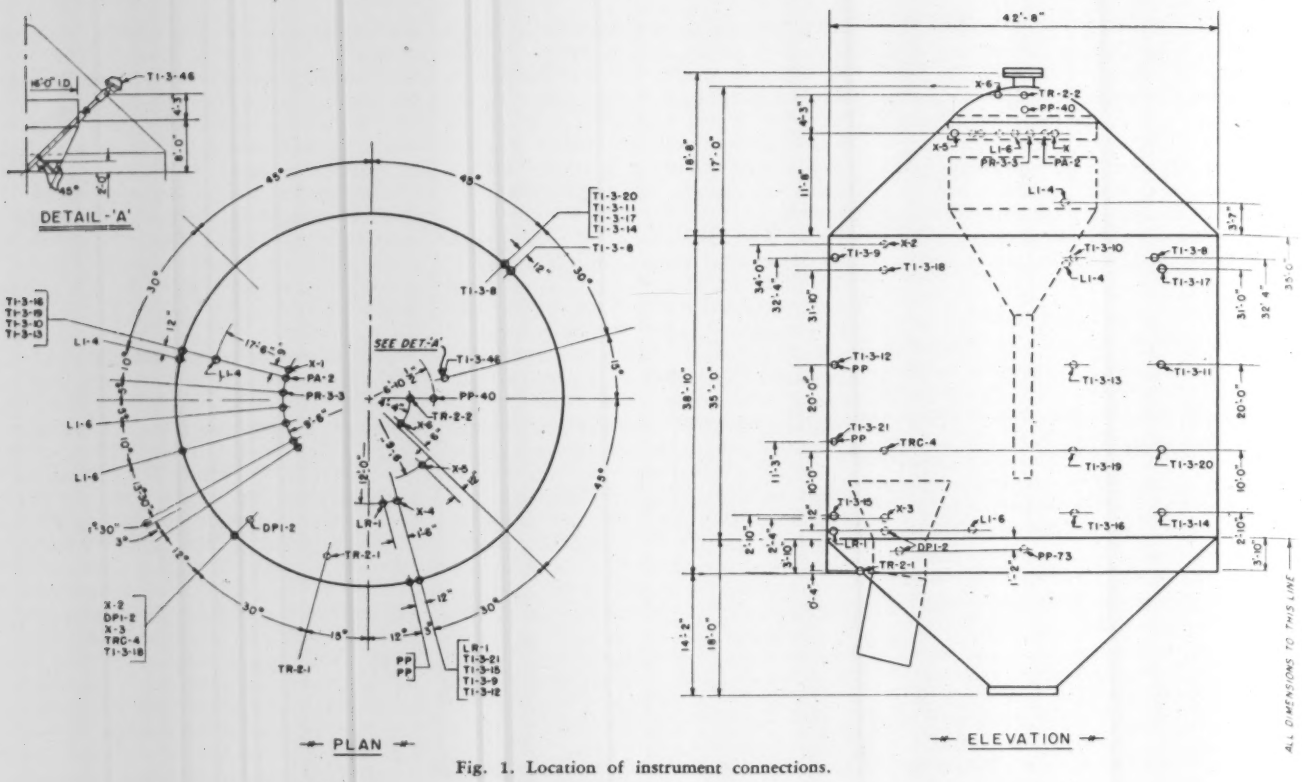
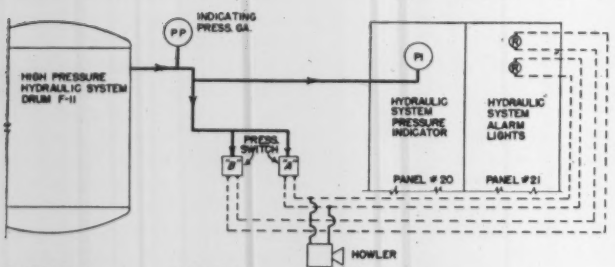


Fig. 1. Location of instrument connections.



EQUIPMENT	LOCATION	DATA
PRESSURE CONNECTION	DRUM F-11-118'6"	OPERATING RANGE = 250 P.S.I.G.
PI PRESSURE INDICATOR	ON PANEL NO. 20	RANGE 0/500 P.S.I.G
PP PRESSURE INDICATOR	DRUM F-11	RANGE 0/500 P.S.I.G.
MERCURY SWITCH "A"	EQUIPMENT 105'0"	LIGHTS LOWER RED LIGHT ON PANEL 21. SOUNDS HOWLER ON LOW PRESS. IN DRUM F-11. SET AT 200 P.S.I.G.
MERCURY SWITCH "B"	EQUIPMENT 105'0"	LIGHTS UPPER RED LIGHT ON PANEL 21. SOUNDS HOWLER ON HIGH PRESS. IN DRUM F-11. SET AT 285 P.S.I.G.

RANGE OF BOURDON TUBES IN MERCURY SWITCH ASSEMBLIES (MERCOID) IS EQUAL TO 600 P.S.I.G.
DIFFERENTIAL BETWEEN OPENING AND CLOSING OF SWITCHES EQUAL NO MORE THAN 4 P.S.I.G.

Fig. 2. Hydraulic system pressure alarm.

tion has a 50" manometer installed in it and not a 100" manometer; that the six orifices for 8" lines were properly identified, sorted out and located in the proper lines; that the four 1" steel control valves (all looking alike externally) were so placed in the lines that the one which is to close with air on the diaphragm is not in one of the other three locations. Such a correlation check, at the end of a big construction job, can bring to light an astounding number of mistakes. The sheer weight of numbers of instrument items is usually to blame. Taking the measuring orifice plates alone, of which there were 67, it was found necessary first to extract information from the drawings, specifications, requisitions, and revision sheets (by the dozen), and prepare a comprehensive tabulation (Table II). This tabulation was used for other purposes than the correlation check, but much of it would have been necessary for the correlation alone. The alternative to the tabulation would be to attempt to extract the needed information from the sources mentioned, in a piecemeal fashion. This would result either in (a) more time being consumed, or (b) more mistakes. Several such tabulations, each for a specific class of equipment, were used on the job under discussion.

The final operating test of all instruments, Item 15 of Table I, consumed 803 man-hours. This test is the equivalent of a full-scale dress rehearsal, in which everything of an operational nature is checked that can be checked without the running process conditions. The purpose is to detect the malfunctioning of any individual piece of equipment, from a supply air reducing valve to a hydraulic oil supply pump. At this time also the proportional bands and reset rates are set at approximately correct values and the operation of the control mechanisms is checked.

Item 16, last on the list but by no means the least with its charge of 1834 man-hours, has a descriptive title—"Office and engineering—inventory, records, instrument location and identification layouts, explanatory diagrams." One of the jobs covered by this item has already been discussed—the making of tabulations such as Table II. It was also necessary to set up certain records for the refinery accounting department, and advantage was taken of the detailed knowledge available and being used during the construction period to prepare the accounting records at the same time.

An example of the "instrument location" portion of Item 16 is given in Fig. 1. This diagram locates all of the instrument connections on one of the vessels of the unit. It is in one sense comparable to Table II, as it represents the extraction, from several sources, of specific instrument information. Such diagrams are rarely if ever made for construction purposes; in order to have such information available in practical form for the operating instrument people it is necessary to have them prepared. Such diagrams are very helpful to field instrument men even on reasonably simple process units. On the unit being discussed they were essential.

An example of the "explanatory diagrams" part of the description of Item 16 in Table I is given in Fig. 2, which is one of the simpler diagrams of those made up for the unit. Such diagrams are needed only on complex units, when the tie-in of the various components of

TABLE II

Inst. Symbol	Service	Setting Number A-8-	Sealing Fluid	Maximum Flow	R. T. Size	Plate I. D	Line Fluid	Grav. @ 60°	Flow Temp. °F
FRRCa-1	4″ Fuel gas	2500	.....	64,760 cfh.	50″	2.508	Gas	1.2	80
FRCa-1	8″ Fresh feed to unit	2501	G.O.	42,700 gph.	50″	4.755	G.O.	0.870	100
FRCa-2	4″ Heating oil to storage	2502	G.O.	7,854 gph.	50″	2.246	G.O.	0.867	125
FRCa-3	8″ Middle reflux (Pan #2)	2503	G.O.	61,800 gph.	100″	5.319	G.O.	0.876	395
FRCa-4	1½″ slurry transfer	2504	G.O.	2,200 gph.	100″	1.057	Slur.	1.05	490
FRCa-5	10″ slurry to Light Ends Plant	2505	G.O.	75,800 gph.	100″	6.201	Slur.	1.05	490
FRCa-6	10″ slurry to slurry boiler	2506	G.O.	45,900 gph.	50″	5.800	Slur.	1.05	490
FRCa-7	8″ slurry to feed preheater	2507	G.O.	72,600 gph.	200″	5.060	Slur.	1.05	490
FRCa-8	6″ cycle gas oil drawoff	2508	.....	7,100 gph.	20″	2.824	G.O.	0.900	440
FRCa-9	24″ Primary air	2509	.....	1.5 MM cfh.	50″	14.303	Air	1.00	225
FRCa-10	6″ Air to precipitator carrier line	2510	.....	90,000 cfh.	50″	3.506	Air	1.00	225
FRCa-11	30″ Total blower air	2511	.....	4,080 cfh.	50″	21.968	Air	1.00	225
FRCa-12	4″ Steam to reactor feed line	2512	Water	18,000 lb/h.	200″	3.020	Steam	.....	345
FRCa-15	4″ HC gas to reactor feed line	2513	.....	128,500 cfh.	100″	2.930	Gas	1.130	100
FRC-16	6″ steam to West air blower	2514	Water	26,210 lb/h.	100″	4.370	Steam	.....	345
FRC-17	6″ steam to East air blower	2515	Water	26,210 lb/h.	100″	4.370	Steam	.....	345
FRCa-18	1½″ torch oil to regenerator (2″ Setting)	2516	.....	1,345 gph.	50″	1.003	Slur.	1.05	490
FRa-6	10″ steam from slurry boiler	2518	Water	10,000 lb/h.	100″	2.836	Steam	.....	365
FRA-8	6″ Distillate product	2519	.....	13,700 gph.	50″	2.901	Naptha.	0.747	105
FRa-9	20″ L-p. gas from distillate drum	2520	.....	733,000 cfh.	50″	12.248	Gas	1.64	1050
FR-29A	4″ cycle gas oil product to storage	2521	.....	6,930 gph.	100″	1.840	G.O.	0.918	140
FRa-15	6″ stripping steam to reactor	2522	Water	20,990 lb/h.	100″	4.003	Steam	.....	345
FR-3	6″ total stripping steam to fractionator & stripping tower	2523	Water	6,100 lb/h.	50″	3.541	Steam	.....	265
FR-12	4″ aeration air or *steam to regenerator standpipe	2524	.....	cfh.	50″	2.583	Air	.....	100
		2524	.....	6,550 lb/h.	50″	2.583	Steam	.....	345
FR-13	4″ aeration air to precipitator standpipes	2525	.....	1,200 cfh.	20″	0.504	Air	1.00	100
FR-17	10″ steam from waste heat boilers	2527	Water	35,900 lb/h.	50″	6.097	Steam	.....	365
FR-18	14″ service water to surface condensers	2528	.....	300,000 gph.	150″		Water	1.00	85
FR-19	10″ blower air to dryer	2529	.....	552,000 cfh.	50″	8.042	Air	1.00	225
FR-21	8″ water from distillate condensers to blowdown drum	2530	.....	41,140 gph.	50″	5.170	Water	1.00	87
FR-22	12″ steam to unit	2531	Water	119,500 lb/h.	200″	8.004	Steam	.....	.....
FR-23	10″ exhaust steam from unit	2532	Water	52,500 lb/h.	200″	7.034	Steam	.....	250
FR-24	6″ H-p. Steam to l-p steam line	2533	Water	24,200 lb/h.	100″	4.246	Steam	.....	.....
FR-26	6″ total steam to cracking section	2534	Water	21,000 lb/h.	100″	4.006	Steam	.....	.....
FRx-28	20″ service water to unit	2535	.....	763,000 gph.	50″	Pitot Tube	Water	1.000	87
*FI-1	4″ air to fresh make-up injectors	2536	.....	66,000 cfh.	50″	2.741	Air	1.00	100
*FI-2	10″ carrier air line PA-17	2537	.....	360,000 cfh.	50″	6.463	Air	1.00	100
*FI-5	4″ stripping steam to reactor bottom ring	2538	Water	7,054 lb/h.	100″	2.367	Steam	.....	.....
*FI-6	2″ aeration steam, spent standpipe	2539	Water	553 lb/h.	20″	1.009	Steam	.....	345
*FI-17	8″ steam to East waste heat boiler	2540	Water	5,000 lb/h.	100″	2.722	Steam	.....	267
*FI-18	1″ aeration gas to reactor dip pipe (2″ setting)	2541	.....	808 cfh.	20″	0.380	Gas	1.00	100
*FI-19	30″ secondary air	2542	.....	2.8 MM cfh.	20″	22.927	Air	1.00	225
*FI-20	2″ aeration steam to reactor cyclone hopper	2543	Water	854 lb/h.	50″	0.998	Steam	.....	345
*FI-21	1½″ steam to ejectors	2544	Water	553 lb/h.	20″	1.009	Steam	.....	345
*FI-23	4″ regenerator, removal carrier air	2545	.....	88,000 cfh.	100″	2.647	Air	1.00	100
*FI-24	4″ precipitator, removal carrier air	2546	.....	88,000 cfh.	100″	2.647	Air	1.00	100
*FI-25	4″ aeration air to No. 1 precipitator hopper	2547	.....	36,000 cfh.	100″	1.800	.....	.....	.....
*FI-26	4″ aeration air to No. 2 precipitator hopper	2548	.....	36,000 cfh.	100″	1.800	.....	.....	.....
*FI-36	3″ aeration air to regenerator cyclone hopper	2549	.....	24,000 cfh.	50″	1.794	Air	.....	100
					50″	1.794	Steam	.....	.....
*FI-38	8″ steam to West waste heat boiler outlet	2550	Water	5,000 lb/h.	100″	2.722	Steam	.....	267
*FI-39	4″ aeration air to No. 3 precipitator hopper	2551	.....	36,000 cfh.	100″	1.800	.....	.....	.....
*FI-40	4″ aeration air to No. 4 precipitator hopper	2552	.....	36,000 cfh.	100″	1.800	.....	.....	.....
*FI-53	2″aeration air to South storage hopper	2553	.....	9,000 cfh.	50″	0.909	Air	.....	100
*FI-54	2″ aeration air to middle storage hopper	2554	.....	9,000 cfh.	50″	0.910	Air	.....	100
*FI-55	2″ aeration air to North storage hopper	2555	.....	9,000 cfh.	50″	0.910	Air	.....	100
*FI-57	2″ water to West waste heat boiler outlet	2556	.....	3,600 gph.	100″	1.325	Water	1.00	115
*FI-58	2″ water to East waste heat boiler outlet	2557	.....	3,600 gph.	100″	1.325	Water	.....	115
FI-59	2″ slurry to settler	2558	G&W†	2,690 gph.	100″	1.151	Slur.	0.95	425
FI-60	2″ clarified oil from settler	2559	G&W†	3,570 gph.	100″	1.293	Slur.	0.95	350
FI-61	2″ cycle oil to settler	2560	G&W†	1,764 gph.	100″	0.957	Slur.	0.9	510
FI-62	2″ slurry from settler to reactor	2561	G&W†	2,600 gph.	100″	1.132	Slur.	0.92	450
FI-63	2″ slurry feed to settler	2562	G&W†	2,730 gph.	100″	1.144	Slur.	0.90	350
FI-64	2″ water to regenerator	2563	Water	2,346 gph.	100″	1.090	Water	1.00	212
FRa-11	10″ reflux to fractionator top	2576	.....	92,000 gph.	50″	7.120	Naptha	0.718	150
FRa-16A	3″ total water to regenerator spray system	2577	Line fl.	13,700 gph.	50″	2.150	Water	.....	350
	3″ boiler feed water to slurry boiler	2517	Water	5,600 gph.	50″	1.938	.....	.....	350
FI-65A	16″ starting air (line SA-1)	2575	Line fl.	558,000 cfh.	121″	9.272	.....	.....	1000
	10″ total steam to air comp. and blowers	2526	Water			7.323	.....	.....	.....
	2″ instrument air line	2574	Line fl.			1.224	.....	.....	.....

* Mercuryless flowmeters

† Glycerine and Water

a specific control system is not obvious to a new field man. They bridge the gap between utter confusion and quick learning for a newly assigned man. On a complex unit they are also needed by the man experienced on the unit, for frequent reference, and when "trouble-shooting."

Summary and Conclusions

It was stated in the introduction that the time recorded in Table I was the time spent to bridge the gap between "Construction" and the actual operation of the process unit. The builder might look at Table I and find many items which to him are not "construction." The operator and his instrument people would insist, however, that every item be taken care of before oil is pumped into the charging line. It may be that both are right, and that on such a complex (when viewed in its totality) batch of equipment, the preparation for operation is a separate and distinct field, being neither the one nor the other. The difficulty is that all too often it is not properly taken care of by either party.

The data which form the basis of Table I were collected for cost accounting purposes. Therefore, for the purposes of this presentation, some items are not clear-cut and some of them overlap. In addition, some jobs that are known to have been performed are not indicated. Despite all such shortcomings, the table clearly illustrates the need for specialized personnel to perform specific tasks prior to the operation of the process unit. When the operators are putting a large and complex process unit through the initial stages of operation, the "come-up" as it is termed, data from the measurement and control instruments are more vital than at any other time in the life of the unit. Thus it should be obvious that the "come-up" is positively not the time to encounter a multitude of instrument troubles. As illustrated by the discussion of Item 6 (Pyrometric Equipment), such troubles must be ferreted out before starting up.

The question may be asked—what happens when the services outlined here are not given? Suppose the builders "construct" a unit, walk off, and the operators take over and start pumping oil into the charging line? It is easy to answer this question, for it has been answered "in the flesh" many times. The answer lies in the number of operators with reduced confidence in measurement and control devices; it lies in the large number of controllers by-passed or on hand control. Many examples could be cited of units that were delayed days or weeks in making specification product because of inaccurate, poor and unreliable data reported by the indicators and recorders, and improper functioning of the controllers. All this is overcome by what may be termed prenatal care. In short, the answer is: if the measuring and controlling equipment is to be forgotten between "construction" and operation, don't buy it at all.

A Statistically Accurate Scaling Method* for Radioactivity Measurements

By WILLIAM E. BARBOUR, Jr., Tracerlab, Inc., Boston, Mass.

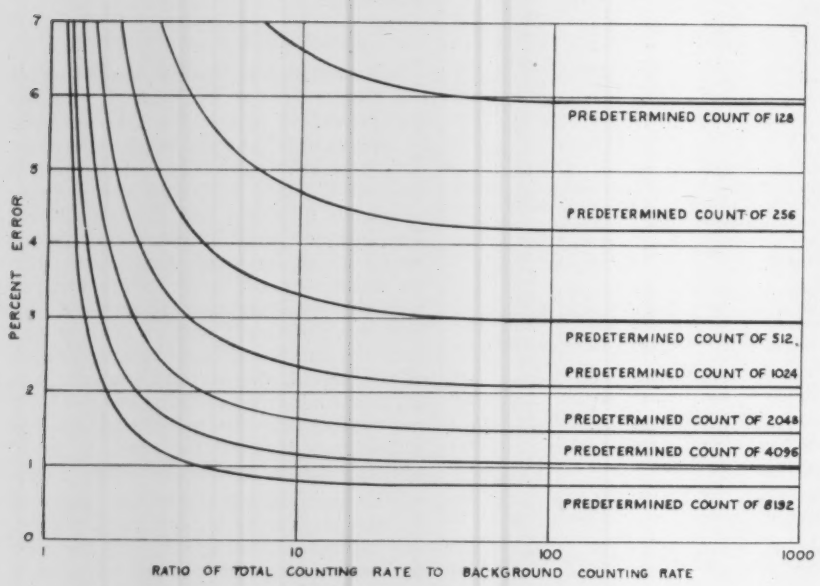

PERCENT ERROR
PREDETERMINED COUNT OF 128
PREDETERMINED COUNT OF 256
PREDETERMINED COUNT OF 512
PREDETERMINED COUNT OF 1024
PREDETERMINED COUNT OF 2048
PREDETERMINED COUNT OF 4096
PREDETERMINED COUNT OF 8192
RATIO OF TOTAL COUNTING RATE TO BACKGROUND COUNTING RATE

Fig. 1. Chart showing statistical error as a function of the ratio of the total counting rate to the background counting rate for different settings of the scale selector switch.

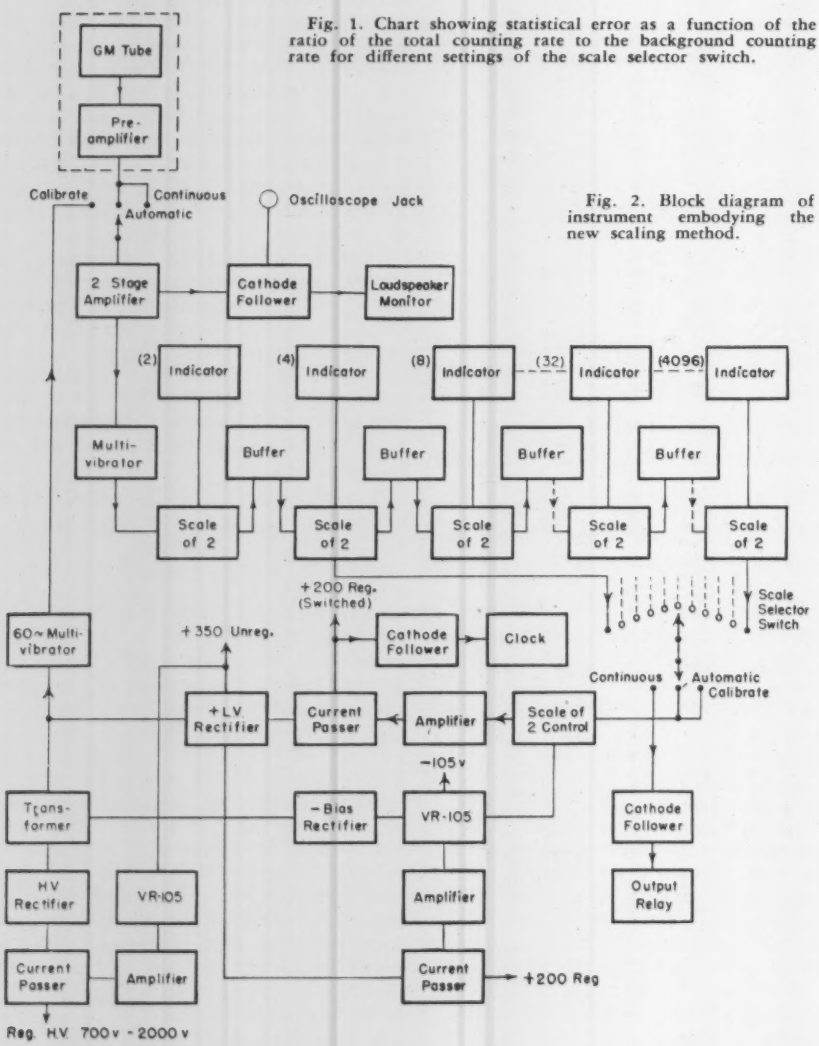


Fig. 2. Block diagram of instrument embodying the new scaling method.

RECENTLY the Manhattan Project has begun to release a large number of radio-isotopes for research in tracer techniques and in therapeutic medicine. Scientists are looking forward to extending the availability of these isotopes for use in controlling chemical and industrial processes. Several thousand such uses have been suggested, some of which have already been successfully tested with cyclotron produced materials.

These radio-isotopes are identified by the emission of alpha, beta or gamma rays, singly or in combination. The alpha rays are helium nuclei; beta rays are electrons; and gamma rays consist of radiation similar to x-rays. The energy content and thus the penetrating ability of these rays varies with the isotopes which produce them.

In tracer technique it is necessary to use instruments which will detect and in some cases differentiate between these various rays. Frequently an instrument is used which actually counts the number of alpha, beta and gamma rays emitted in a certain time.

The highest degree of accuracy in measuring the number of individual particles or radiations is obtained by using the Geiger-Mueller counter tube and an electronic input circuit to convert the impulses received by the G-M tube into homogeneous square pulses of equal amplitude. These random square pulses are then fed into a scaling circuit to totalize them for a given period of time. The longer the time, or axiomatically the larger the number of counts totalized, the lower will be the statistical error. The error inherent in the measurement of random events is an inverse function of the total number of events counted.

The conventional method of scaling or measuring radioactive emanations has been to select a convenient time, say ten minutes, and count the impulses received, divide by the time, and compute the statistical error with formulae or charts. If the error is unreasonably high, the run must be repeated for a longer period of time. The error for successive readings of different samples will vary inversely with the strength of the samples even if all measurements are conducted for a given period of time. Therefore, successive test results on different samples are not directly comparable. Neither is the reading of background from cosmic rays and con-

*The author gratefully acknowledges the valuable suggestions of scaling methods by Dr. Wendell C. Peacock, Massachusetts Institute of Technology.—W.E.B.

tamination of the surroundings directly subtractible from sample readings.

Now if a *predetermined number* of counts is recorded for all readings made on a given group of radioactive samples and the total counting rate is at least ten times the background counting rate, the corresponding statistical errors due to random flow will be equal and, therefore, the results comparable. The new method herein described utilizes this new principle: Impulses from the G-M counter are fed to a preamplifier, a 2-stage amplifier, and then a multivibrator which triggers the first of a series of twelve "scale-of-two" counter circuits. The latter can be selected by a switch (the switch shown in the upper left of Fig. 3) to provide a predetermined number of impulses from 2 to the second power to 2 to the twelfth power —i.e., 4 to 4096—in integral powers of 2. As previously pointed out, the statistical error involved in the measurement of an average counting rate by timing a finite number of random impulses is determined by the total number of impulses timed. Fig. 1 shows how predetermined counts of 128, 256, 512, 1024, 2048 and 4096 correspond to fixed probable errors of approximately 6%, 4%, 3%, 2%, 1.5% and 1%, respectively.

Measurement of the time interval required for the accumulation of the selected number of impulses is accomplished by feeding the output of the scaler into an output amplifier and cathode follower stage, which in turn actuates the clutch of an electric clock timer. If the scale selector switch is set on 4096, the 4096th impulse automatically stops the clock through a quick-acting clutch. 4096 divided by the time reading of the clock in seconds gives the average counts per second for the sample statistically good to an accuracy of 1%. If 4096 counts of background are accumulated and a similar division performed, this should be subtracted from the first reading to obtain the *net counts* per second for the sample.

The purpose behind extending the scaling circuit to 4096 instead of stopping at the conventional 64 is two-fold. First, 4096 coresponds, as stated above, to a probable error of one percent, which is a reasonable tolerance for most tracer work. Second, for low-activity samples such as radioactive tracers, the time interval for accumulating 4096 counts is usually of the order of half a minute to ten or fifteen minutes. Shorter periods would introduce appreciable errors due to mechanical clutch action or, as an alternative, require complete electronic timing. Longer periods would be tedious and fatiguing or require an elaborate mechanical sample changer and a printing interval timer.

If, for some extraordinary reason, a higher degree of statistical accuracy were desired, a relay is provided so that the instrument may be operated continuously. The relay can be connected to actuate an external mechanical timer. For a special application an Eagle

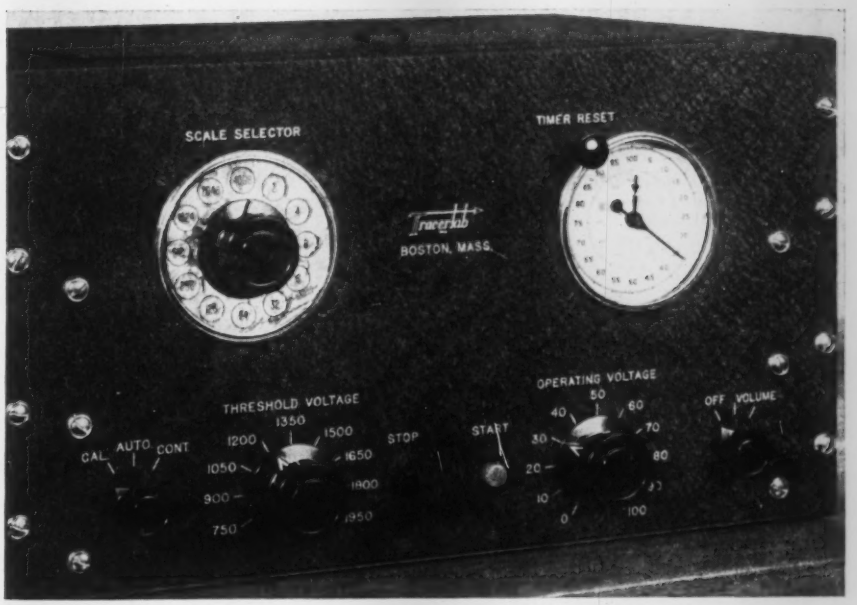


Fig. 3. Panel of instrument embodying the new scaling method. At left, scale selector switch with built-in neon indicating lights. At right, controlled clock.

Fig. 4. Patient's uptake of radio-iodine being measured in the course of treatment of thyroid cancer.

Reset Timer was used which could stop the scaler *after* it had accumulated any integral number of counts from 1 to 400. If it were set at 400 the scaling instrument would stop the clock and shut itself off on receiving the 1,638,400th impulse. (1,638,400 is equal to 400×4096.)

An automatic means of "cleaning up" the scaler is provided so that it is ready to start another test as soon as it is either automatically or manually stopped. In other words, no residue of counts remains in the scaler once it has stopped counting.

For routine laboratory measurements and for biological, therapeutic and industrial tracer work the new method eliminates entirely the necessity for computing statistical error. It further provides an automatic system of totalizing a given number of impulses or radiations and indicates the exact time required to accumulate this number of impulses. These features make the new method of special value to anyone who is principally interested in obtaining quick results with a given degree of accuracy and without lengthy error computations and tedious stopwatch timing.

The new method being automatic, its practical embodiment (Figs. 3 and 4) has been given the name "Autoscaler." Patent application has been filed.

Recent Developments in Gear Inspection Methods

By DON MONCRIEFF, Asst. Chief Engineer, Michigan Tool Co., Detroit, Michigan

QUIET, smooth running gears are the result of intelligent design and accurate workmanship. It is necessary to have suitable, dependable checking equipment and inspectors skilled in their use. It has been erroneously thought that inspection of the gear begins after the teeth are cut. However, it is often too late to make a good gear or to rectify mistakes if control starts at this point. To insure accuracy in gears it is necessary to inspect and control all factors relative to the finished product, beginning with the material.

Heat-treatment Distortions

Most well-managed gear shops take chemical analysis of the steel and only accept materials meeting their specification. If it is impossible to use this method of control, test pieces are hardened out of each shipment of steel. The test pieces are inspected for heat-treatment distortion so that allowances can be made for gears run in regular pro-

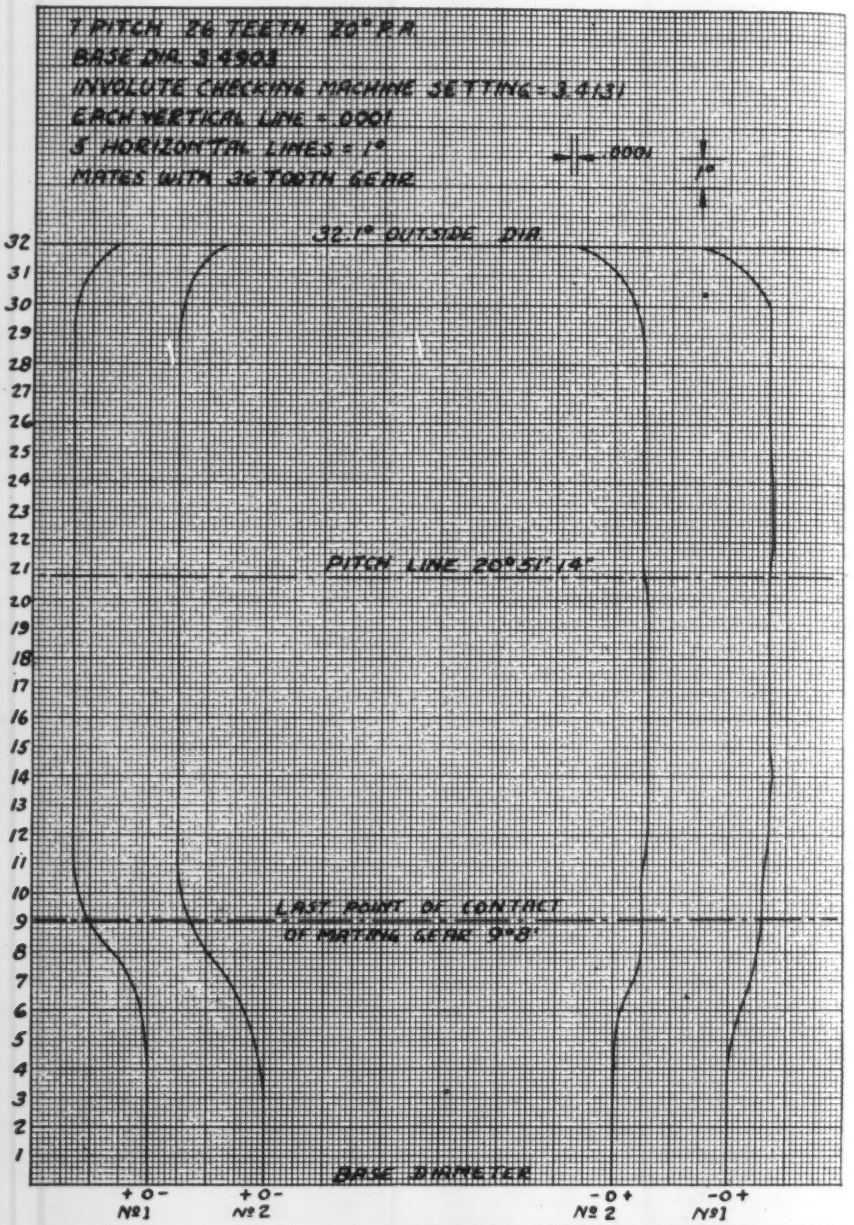


Fig. 2. Chart plotted to show the involute profile of right and left hand surfaces of two gear teeth on a 7-pitch gear.

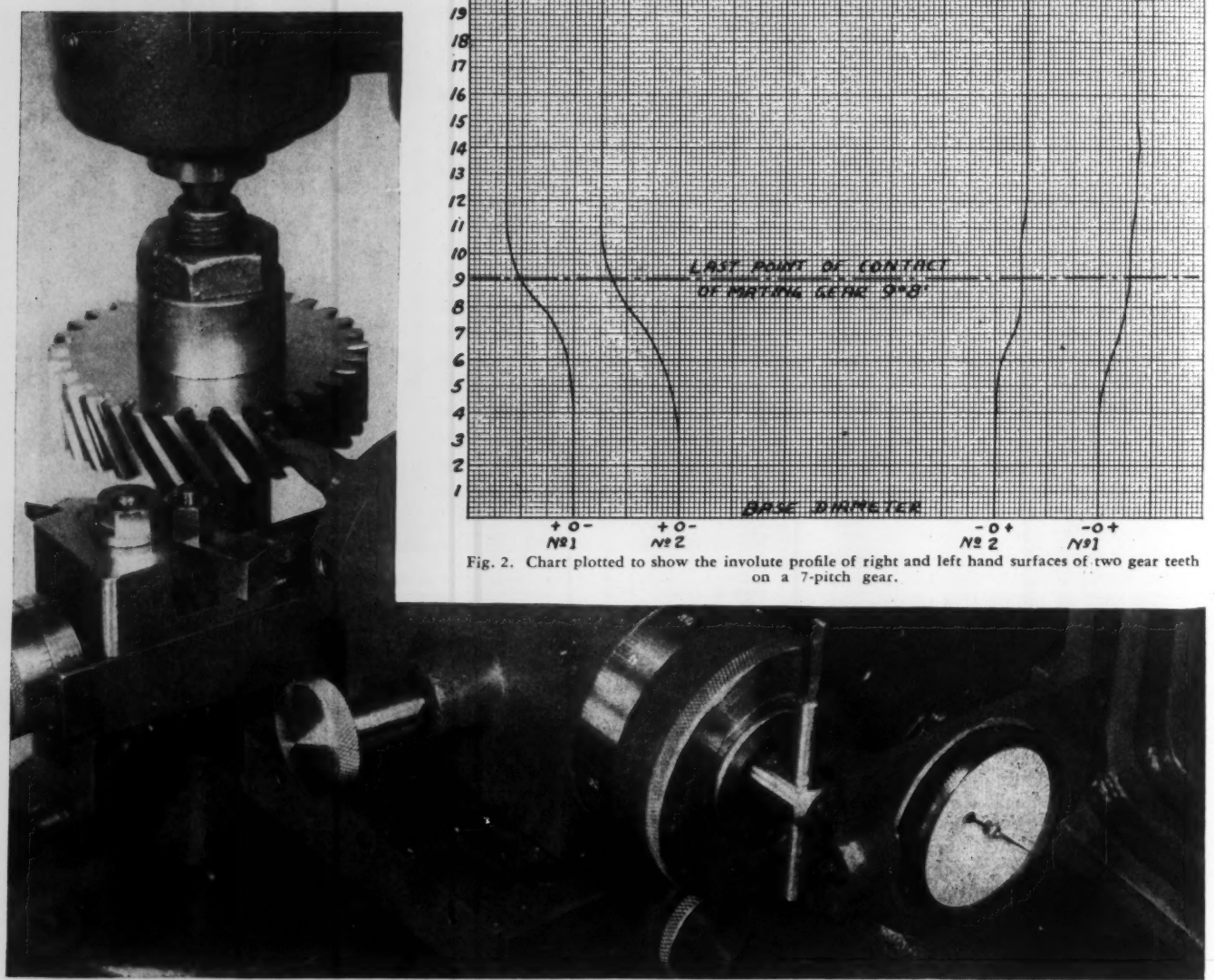


Fig. 1. Use of the Sine-Line Involute Checker for checking the involute form.

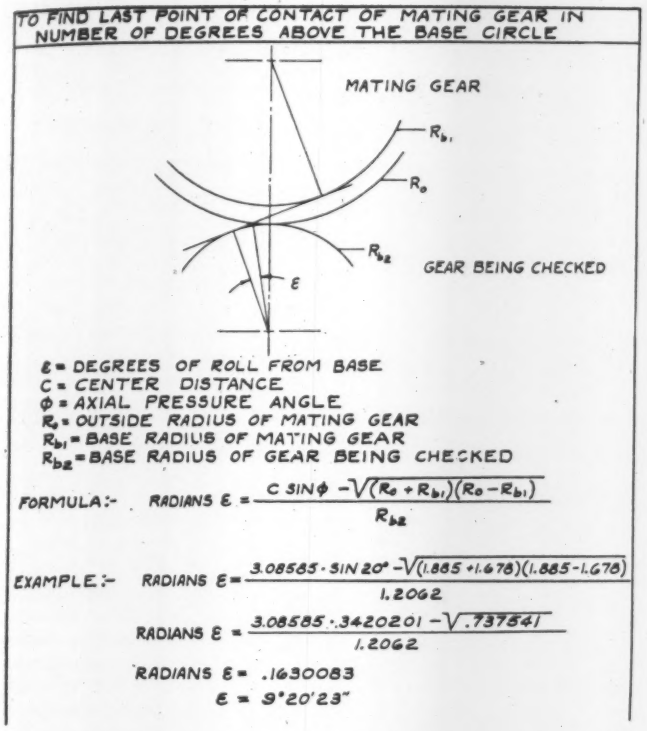

TO FIND LAST POINT OF CONTACT OF MATING GEAR IN NUMBER OF DEGREES ABOVE THE BASE CIRCLE
MATING GEAR
R_{b_1}
R_o
R_{b_2}
GEAR BEING CHECKED
ε
ε = DEGREES OF ROLL FROM BASE
C = CENTER DISTANCE
φ = AXIAL PRESSURE ANGLE
R_o = OUTSIDE RADIUS OF MATING GEAR
R_{b_1} = BASE RADIUS OF MATING GEAR
R_{b_2} = BASE RADIUS OF GEAR BEING CHECKED
FORMULA:- RADIANS $\varepsilon = \frac{C \sin\phi - \sqrt{(R_o + R_{b_1})(R_o - R_{b_1})}}{R_{b_2}}$
EXAMPLE:- RADIANS $\varepsilon = \frac{3.08585 \cdot \sin 20° - \sqrt{(1.885+1.678)(1.885-1.678)}}{1.2062}$
RADIANS $\varepsilon = \frac{3.08585 \cdot .3420201 - \sqrt{.737541}}{1.2062}$
RADIANS ε = .1630083
ε = 9°20'23"

Fig. 3. Formula and method for finding last point of contact of mating gear in number of degrees above the base circle.

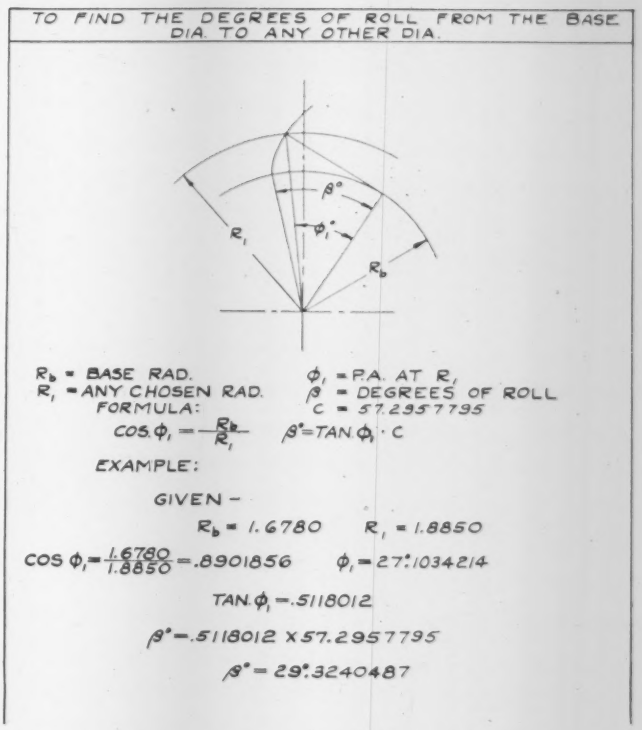


Fig. 4. Method for finding the degree of roll from the base diameter to any other diameter.

duction. Compensation for heat-treatment distortion depends on the method of hardening used. As a general rule, all helical gears have a tendency to straighten out or "unwind" during hardening. The amount of distortion in this respect depends on the types of steel and on the particular heat treatments, and in most cases it can only be determined by trial. Carburized gears have a tendency to broaden out at the base of the teeth, while cyanide-treated gears will have the tendency of broadening at the tip. Allowances must be made for the various types of distortions.

Obtaining accurate gears can only be accomplished through the proper application of gear inspection procedures. All too often, failures to meet specifications after heat treatment are blamed entirely on heat-treatment distortion rather than on inaccuracies introduced before heat-treating.

Before teeth can be cut accurately it is necessary to see that holes are accurate, that they are accurately centered, and that locating surfaces are square with the hole. Gears integral with a shaft should have protected centers and be inspected to see that the centers are not nicked and are free of foreign matter. Unless these factors are given proper attention, the gear will be inaccurate, regardless of the care exercised in cutting the teeth. If the locating surfaces or sides of the gear are not square with the bore the gear blank will be cramped on the forming or generating machine so that an excessive runout is introduced. An eccentric condition can seldom be corrected by subsequent grinding of the bore. It is far better to control the gear blank.

To produce quiet and therefore accurate gears, it is also necessary to control several other elements, among the most essential of which are: tooth profile; tooth spacing; helical lead and spur gear tooth alignment; size; and concentricity. These inspections should be supplemented by a final inspection consisting of sound testing of the completed gear on a speeder.

Checking Tooth Profile

In order to transmit motion smoothly and quietly it is essential that the tooth profile be of uniform cam rise. Any portion of the tooth above the base diameter can be in contact with mating teeth provided the involute is perfectly formed. To allow for manufacturing tolerances the involute form is sometimes modified. Modification may be at the tip of the tooth—to ease contact between the tip of the tooth and flank of the mating tooth. Or the flank of the tooth immediately above the base may be modified or undercut, since this portion of the involute is most difficult to control and to check. A gear never should be modified to such an extent that continuous tooth action is impaired. As mentioned above, quietness is dependent on smooth continuous contact action of mating tooth profiles.

Tooth profile may be checked on a Michigan Sine-Line Involute Checker which works on a sine-bar principle, eliminating use of master forms or multiple master base circle disks (Fig. 1). The gear is mounted between centers and an indicator finger brought into contact with the tooth profile. The movement of the finger and rotation of the gear are synchronized so that for one degree of rotation of the gear the indicating finger moves 1/360 part of the circumference of the base diameter of the gear being checked. The Involute Checker is operated by a hand wheel, each turn of which equals 2° rotation of the gear.

One form of record for retaining readings obtained with the Checker is shown in Fig. 2. The charted lines on the left have a plus sign on the left of the vertical center-line of the graph. The charted lines on the right have the plus and minus symbols reversed. Thus the chart gives the impression of looking at a cross section of a gear tooth. The horizontal line at the bottom of the chart represents the base circle of the gear being checked. The gear rotates while it is checked, offering a basis for locating the last point of contact of the mating gear, the pitch line, and the outside diameter of the gear being checked. Degrees of rotation are given at the left of the chart. Horizontal lines indicate last point of contact, the pitch line, and the outside diameter. Vertical lines of the graph represent 0.0001".

Lines are plotted by taking indicator readings every one or two degrees as required. If a perfect involute were charted, the resultant graph line would be straight. On the sample chart, Fig. 2, the involute of the gear checks within one ten-thousandth from 11° to 30°. From 30° to the O.D. there is a modification of about one-thousandth. There is also a modification of 0.0012 to 0.0015 11° to the base circle. The chart therefore indicates that the gear would operate satisfactorily, there being a modification below the active portion of the

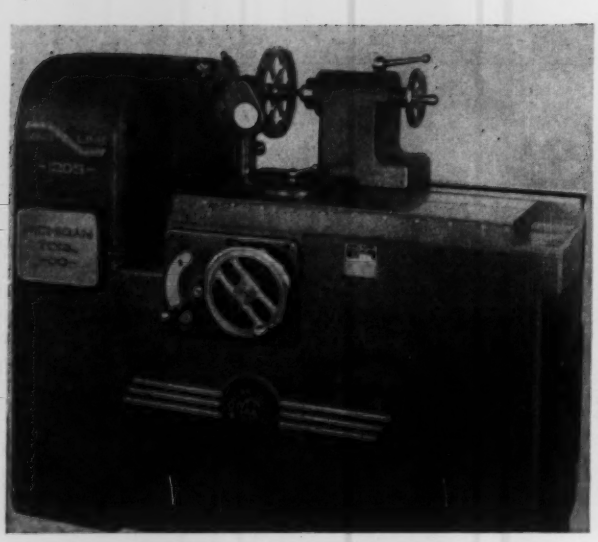


Fig. 5. This Sine-Line Lead Checker will check the leads of gears from zero to infinity.

Fig. 6. The lead of both internal and external helical gears is being checked on these two single-purpose lead checkers.

involute and a modification of a few tenths at the O.D. to ease contact with the mating gears as the gear teeth come into mesh.

Fig. 3 is a formula for finding the last point of contact of the mating gears in number of degrees of rotation of the gear on the checker. Formulas for location in degrees of roll of the pitch line and outside diameter are shown in Fig. 4.

Shaper cutters, master gears, and involute splines may also be checked on the Involute Checker.

Hob Contour Checking

A Hob Contour Checker may be used for checking the profile of hobs. This checker, which is limited in use to inspection of hob and worm profiles, works on the sine-bar principle. The hob is mounted on an arbor integral with a sin-bar table which is adjusted to the proper angle. A knife-edge finger is brought into contact with the hob tooth profile and moved across the tooth surface to indicate irregularities.

Tooth Spacing

Tooth spacing is best checked along the line of action between two gears. The distance between adjacent involutes along the line of action is the base pitch. Tooth spacing and tooth form can be checked on an Involute Checking Machine. The indicator contact finger is located tangent to the base circle (on line of action). The positive stop is located on the line of action and the distance between the contact finger and positive stop is equal to the base pitch of the gear being checked. In cases where the root diameter is above the base diameter, the contact finger and positive stop are moved tangent to the base circle without disturbing their position relative to each other, until they are located in proper contact with the gear teeth.

Helical Gear Lead and Spur Gear Tooth Alignment Checking

To avoid misalignment of tooth surfaces or a condition of mismated helices, checking parallelism of spur gears or lead of helical gears is an absolute necessity. Fig. 5 shows a machine that will check helix angles on helical, worm, or spurs gears from zero to infinity. The gear is placed between centers and an indicating finger brought into contact at any desired depth on the gear tooth. The finger is integral with a ball-mounted table which moves parallel to the face of the gear being checked. Movement of the indicator finger and rotation of the gear are synchronized by setting an adjustable sine-bar. The machine is operated by turning a single hand wheel. Errors in alignment are read on a 0.0001" indicator, or may be recorded with an automatic recorder.

Another machine (Fig. 6) for quickly and accurately checking lead in gears in production is useful in shops employing large numbers of gear shaving machines, to facilitate setting the crossed-axis angle on the shaving machine. The machine employs a master lead equipped with three or four starts equally spaced about its periphery. An indicator is placed in contact with one of the gear tooth surfaces and the gear is guided past the indicator by a master lead. Both gear and master gear are mounted on a single spindle. Without changing the position of the gear on the spindle, three or four teeth can be checked, depending on the number of starts on the master.

Hob Lead Checking

Contact between an involute profile and a straight-sided rack tooth occurs only on a straight line. This straight line is known as the line of action between a hob and the gear being generated. To check both line of action and lead of a hob, a Hob & Worm Lead Checker may be used. In the Michigan "Sine-Line" machine, a new method of hob inspection and control was introduced, offering a composite test for hobs. A supplementary sine-bar imparts motion to the indicator contact finger at right angles to motion imparted by the first sine-bar. Thus, leads of worms and hobs that fall between zero and 18" may be checked by using the first sine-bar. Line of action checks on the same hobs are obtained through the simultaneous use of both sine-bars.

While checking the line of action, all elements of hob accuracy are checked simultaneously. If the hob checks to given tolerances, it may be expected to produce an accurate gear, provided that it be mounted in the same position in which it was checked and that hobbing machine errors are negligible.

Size and Concentricity

If size of gears varies materially, they will not mate on the proper center distance, or the gears are likely to bind in operation by reason of heat expansion. Failure due to binding may also result if the gears are extremely eccentric. A testing machine developed at Michigan is useful for checking gear size over rolls, eccentricity over a pin, and parallelism of spur gear tee h. In addition, all pertinent elements affected when sharpening a hob or milling cutter can be inspected on this machine.

Gear Speeder Test

The combined effect of all gear errors will show up in a test run on a speeder designed to duplicate as nearly as possible actual operating conditions. An excellent type of speeder, which was developed to meet virtually every demand for running two mating gears, is equipped with a drive mechanism which may be applied to either spindle while a brake load is applied to the spindle holding the mating gear. However, with each spindle turning in the same direction, the driving and braking action may be reversed to simulate the action of a car transmission under drive and coast conditions. Four spindle speeds are provided ranging from 580 to 1740 rpm. A larger speeder of the same basic design provides a range of speeds from 580 to 1800 rpm. and will take gears up to 13" diameter.

Some Considerations in the Control of CONTINUOUS PROCESSES

By H. C. FROST, Chemical Division, Corn Products Refining Co., Argo, Illinois

ENGINEERS in many fields of endeavor are finding it increasingly necessary to make use of instrumentation in connection with their work. This is particularly true of the process engineer, who finds that many processes can be operated satisfactorily only if the full advantages of modern instrumentation are utilized. Because of the rapid advances in this field within the past decade, many engineers find it difficult to keep up with improvements and changes in methods of instrumentation.

Benefits from modern instrumentation accrue not only in the use of automatic controls to regulate continuous processes or schedule batch process operations, but also in the application of certain measuring techniques which may be used to give the operator information continuously which heretofore he had to obtain by lengthy chemical analysis or do without altogether. Likewise, in conducting tests and investigations on unit operations within the process where there is needed specialized information important to the equipment designer and to the engineer concerned with the material and heat balances, measuring instruments are proving of greater and greater value.

Recognizing the benefits which might be gained from an up-to-date approach to measurement and control problems, a few of the larger companies in the chemical and oil refining fields have organized groups of specialists whose sole responsibility is to work on problems in which measurement and control may be involved. Because of their past experience and continued interest in such problems, this group can keep up-to-date on all new developments and, in some cases, may find it necessary to develop specialized measuring tools to meet specific requirements. They can take advantage of benefits to be gained through the use of a number of different makes of instruments which can be combined on a particular process in a manner superior to an arrangement of equipment obtained from only one or two manufacturers. They can design into the process those instruments needed to realize optimum performance and efficiency. Where it is necessary to maintain secrecy concerning certain new developments, this group of specialists can accomplish their work without revealing information to outsiders. Probably the greatest benefit, though, is in the complete follow-through from the inception of the process in the Research Department until the process equipment has been installed and satisfactory operation is assured.

Other than these relatively few large companies, most companies find it necessary to depend considerably on the instrument manufacturers for help in their instrumentation problems. Because of the time consumed in discussions with the representatives of a number of the manufacturers, and because of lack of knowledge of just what the various manufacturers are prepared to furnish, most companies resort to dependence on one or two suppliers for all of their needs. A further source of delay, particularly among users located in areas remote from the large urban centers, is the lack of prompt availability of the manufacturers' field engineers. Often a user lacks knowledge of what information a supplier will need on a specific problem to permit recommendations to be made, and this factor is particularly bothersome where secrecy concerning the process must be maintained.

The purpose of this discussion is to acquaint engineers with some of the less generally used measurements and controls, to outline the type of information which suppliers need in order to recommend certain measuring and control equipment, and to offer suggestions regarding installation of such apparatus in the process. Theoretical discussions of the measuring methods and mathematical analyses of the control problems are not included. Instead, an attempt has been made to look at problems both from the users' and the suppliers' viewpoint, and to indicate the type of information which each should have from the other in order to permit satisfactory installations to be made.

Every process engineer has probably reflected that the ideal chemical process would be a straight pipe line with the raw material introduced into one end and the finished product flowing continuously out of the other end. The trend is toward process simplification; and modern instruments are helping in the realization of improvements. Automatic controls must be considered in the design of such a process, though; and many times they dictate the equipment and piping arrangement. As a basis for considering some of these problems, a hypothetical process has been conceived, and a number of different types of measurements and controls will be applied as they might be on an actual process.

The elements of the process are shown in Fig. 1, where it will be noted that the process comprises the finishing operations on a material which has been treated previously in such a manner that a phase separation occurs. We shall be concerned only with the heavier phase which is drawn off of the bottom

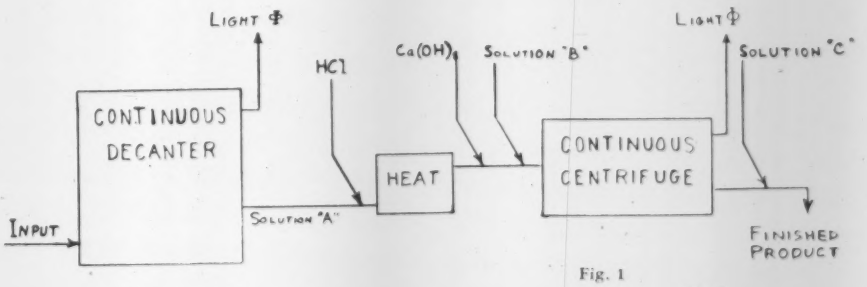
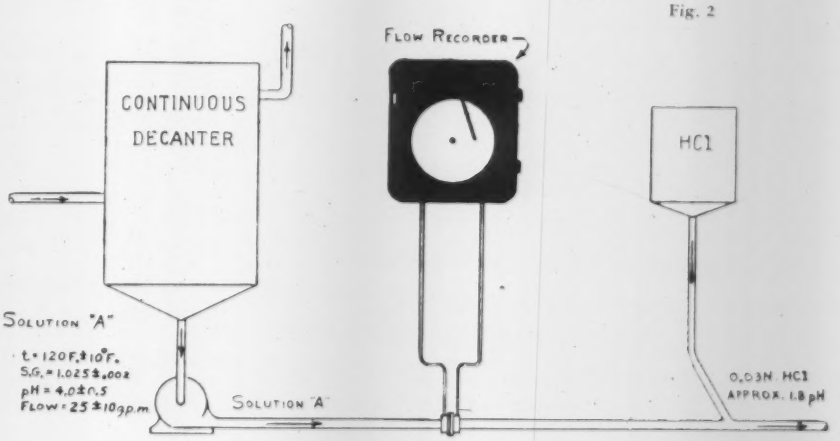


Fig. 1

Fig. 2



Presented at the first Annual Conference of the Instrument Society of America, William Penn Hotel, Pittsburgh, Penna., Sept. 16-20, 1946.

NOTE: Statements and opinions advanced in papers are to be understood as individual expressions of their authors and not those of the Society.

of the continuous decanter. This process flow diagram has been drawn to approximate the process engineer's ideal pipeline process with various reagents added along the pipe line to effect the final product. Each of the several operations in the process will be considered separately.

Solution "A" Flow Integrating Recorder

For record purposes and as a guide in the operation of the process, it will be desirable to provide a flow recorder to meter the flow of solution "A" out of the continuous decanter. Fig. 2 shows solution "A" being metered continuously before the addition of the hydrochloric acid. If the material is a clear freely-flowing liquid, the measurement may be made with an orifice type primary element, but if the material contains solids in suspension, or if it is sticky or very viscous, the problem of selecting the proper measuring element becomes more difficult. A Venturi tube, although higher in first cost than an orifice, can be used in many cases to measure the flow of materials where an orifice would be unsatisfactory. Area type meters, such as rotameters, which are widely available today, are being used more and more for the measurement of the flow of materials which are difficult to handle with a differential-pressure type of primary element. With such an element the need for minimum lengths of straight pipe or for straightening vanes will be evident.

A supplier, before recommending equipment to make this measurement would require:

1. The conditions, with limits, as indicated.
2. The pipe size and material, and upstream pressure at the point of measurement.
3. The nature of the solution; that is, whether it is clear, a slurry, viscous, or sticky.
4. Whether an integration of the flow rate is required.
5. The relative location of the recorder with respect to the primary element.
6. The type of record required.
7. Accuracy of recording and integration needed.
8. Nature of the atmosphere in the area surrounding the recording device and its accessories.

Acid Catalyst Addition

The chemical reaction required necessitates the use of hydrochloric acid as a catalyst and, since the process material is flowing continuously, the acid must be added continuously. It is desired that the acid addition be sufficient to make its concentration in the solution 0.03 normal. It might be expected that the measurement of this acidic concentration could be made with a continuous pH measuring instrument. Reference to Fig. 3 will indicate that a curve showing the relation of volumetric units of acid added per unit volume of solution versus pH changes slope very rapidly; and that at 2 pH the measurement is insensitive to changes in rate of acid addition. The reason for the unfavorable slope in the curve is that pH is a logarithmic function of hydrogen ion concentration; and reference to the

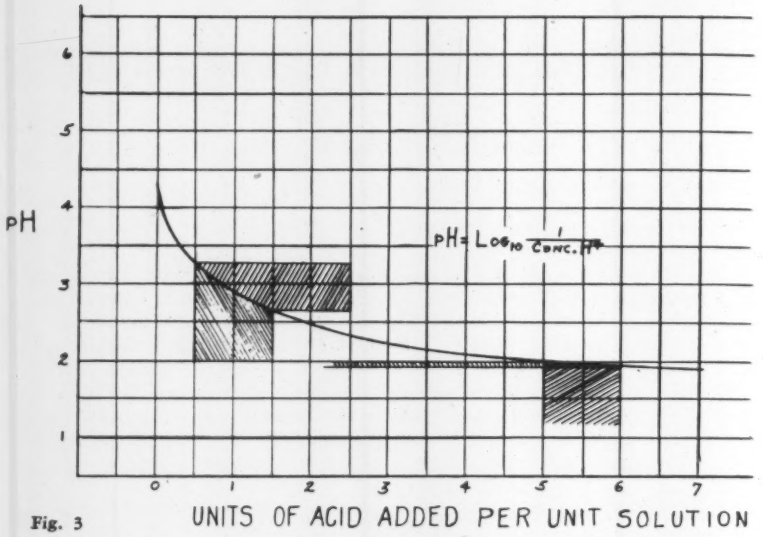


Fig. 3

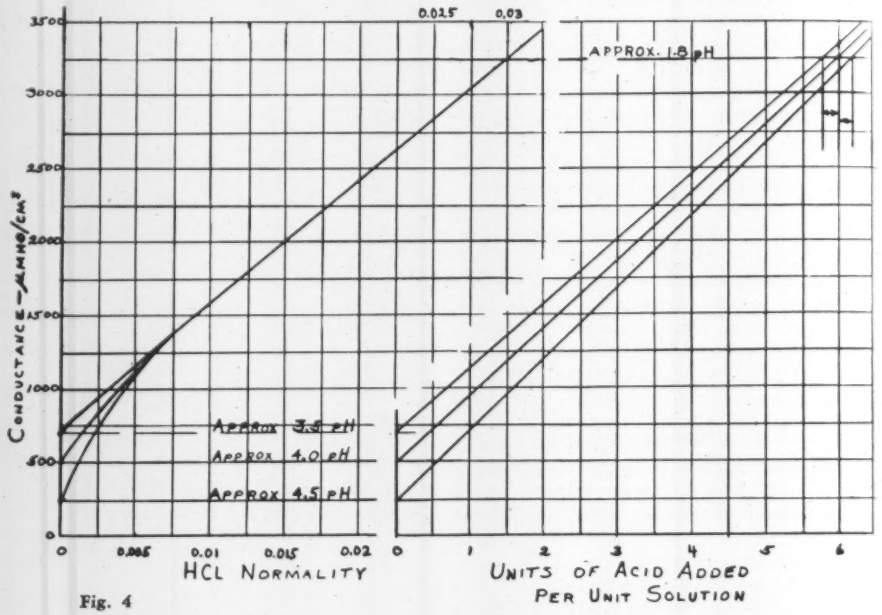


Fig. 4

curve will show that while the measurement might have been adequately sensitive at 3 pH, it is of little value at 1.8 pH, which corresponds to the desired acidic concentration.

A possible approach is through measurement of total ion concentration rather than hydrogen ion concentration. Total ion concentration may be measured with an electrolytic conductivity cell, and the curves at the right side of Fig. 4 show the relation of unit volume of acid added per unit volume of solution versus specific conductance. The initial conductance differs, depending upon the initial pH of the solution, but, as acid is added, the curves tend to converge slightly since total ionization depends more and more upon hydrochloric acid concentration as the acid concentration is increased. Reference to the curves at the left side of this drawing shows that above 0.008 normal, specific conductance may be related directly to hydrochloric acid normality. Since the desired control point is 0.03 normal, the corresponding specific conductance is 3250 μmho/cm.³. Reference to the curves at the right will indicate that at this conductance, the quantity of acid required per unit volume of solution varies with the pH of the incoming material. Hence, if an attempt were made to control acid addition on a volumetric flow ratio basis, variations of ±5% above and below the desired control point might be expected. Through use of conductance control, however, the necessary changes in volume of acid added per unit volume of solution will be made to maintain the desired control point regardless of incoming-material pH. The straight-line relation between acid requirement and conductance makes the application of automatic control much simpler than would be the case if the curves had constantly-changing slopes.

Application of the conductance method requires a study of the materials to determine their possible effect on the conductivity cell. It is particularly important to make certain that the solution contains no oily or sticky materials which might cling to the cell electrodes and insulate them from the solution.

Ordinarily, the flow of acid into the

process material would be controlled with a valve. Generally, the volume of acid required per minute is so small that it is difficult, if not impossible, to obtain a valve which will satisfactorily regulate the flow of concentrated acid. Also, under some conditions, it might prove difficult to mix the concentrated acid effectively with the material. It is necessary, then, to dilute the acid in such proportion that the rate of flow of dilute acid may be controlled over the entire range with a valve. It is desirable too that the upstream pressure on the valve be maintained constant, and therefore the dilute acid is generally supplied from a constant-head tank. The valve must be located at a point close to where the acid is being added to the process material so that changes in valve position will be reflected promptly in changes in acid concentration in the process material. Fig. 5 shows the acid being added into the pipe line ahead of a pipe line mixer with the conductivity cell located in the pipe line beyond the outlet of the mixer. It is imperative that the mixer intimately mix the acid with the process material without unduly delaying the flow of material. Since the capacity of the mixer and pipe line between the point of acid addition and the conductivity cell is small, the total time lags in the control circuits, including that imposed by the cell, the measuring device, the control actuating element, and the valve operator, must likewise be small.

Another possible approach would be through the use of a mixing tank into which the process material and dilute acid are added, as shown in Fig. 6. This form of installation adds an extra tank, pump, agitator, and level control to the system, and would be used only in the event that it is impossible to obtain a favorable relation between the system capacity and control lags with a pipe-line mixer. The mixing tank would then provide sufficient capacity to swamp out sudden changes in the rate of flow of the process material or in the incoming pH. We shall assume that an analysis of the control problem has indicated that the pipe-line mixer will provide a satisfactory means of mixing the acid with the process material, and that control can be effected in the pipe line as shown in Fig. 5.

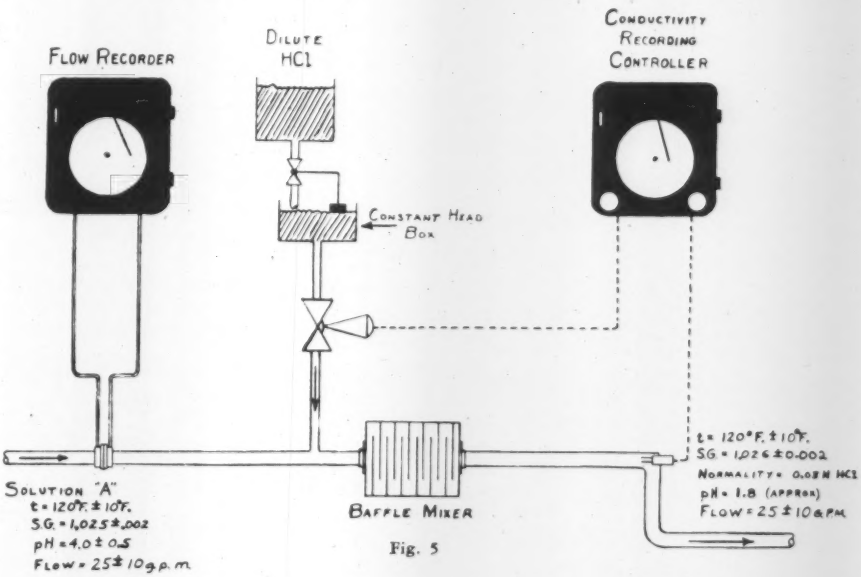

Flow Recorder
Dilute HCl
Conductivity Recording Controller
Constant Head Box
Solution "A"
t = 120°F. ± 10°F.
S.G. = 1.025 ± .002
pH = 4.0 ± 0.5
Flow = 25 ± 10 g.p.m.
Baffle Mixer
t = 120°F. ± 10°F.
S.G. = 1.026 ± 0.002
Normality = 0.03 N HCl
pH = 1.8 (approx)
Flow = 25 ± 10 g.p.m.

Fig. 5

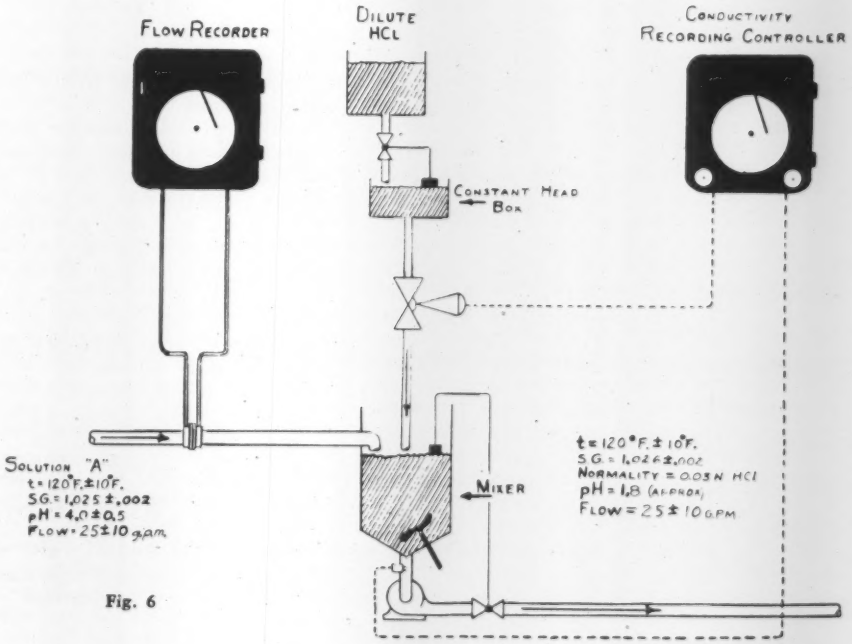


Fig. 6

Consideration of the control requirements indicates the need for a controller having both proportional and automatic-reset features. Changes in the incoming rate of flow and pH dictate a requirement for different rates of flow of dilute acid while maintaining the same conductance, making automatic-reset action imperative. If the cell is installed close to the outlet of the mixer, rapid response may be obtained, and if the controller, valve operator, and valve are properly selected a high proportional sensitivity may be used.

It is important to consider the effect of temperature of the process material on the measurement. Most solutions have a large temperature coefficient of conductance, amounting to more than 1% conductance change per degree F. Since a possible temperature change of ±10°F. is indicated, the changes in conductance with temperature will be significant. Most conductivity-measuring devices are provided with a manually-operated temperature compensator which, when set for the temperature of the solution, refers the conductance measurement to the value which would be obtained at 25°C. (77°F.). Automatic temperature compensation may be effected through the use of a mechanically-balanced temperature recorder which measures continuously the temperature of the solution, and which is used to reset automatically the temperature-compensating slide-wire in the conductivity instrument bridge network. A second possible method of effecting automatic temperature compensation involves the use of a reference conductivity cell containing a solution having the same value of conductance as required at the control point, with the reference cell and the vessel in which the reference liquid is concontained installed in the process material pipe line. Changes in temperature will then affect both cells similarly, and since the reference cell is a part of the bridge network, automatic temperature compensation may be obtained thereby. A third possible method would be the use of a bimetallic spiral exposed to the process material and changing the position of a contact on a slide wire as changes in temperature occur. (Again this slide wire would be incorporated in the bridge network to effect automatic temperature compensation.) It is possible that at some future date a material may be developed which will have a high temperature coefficient of resistance and will be sufficiently stable to serve as a means for automatically compensating for changes in process

material temperature. A resistor made of this material would be exposed to the process material and would replace the manually-operated temperature compensator.

In order to make recommendations on equipment and method of application, a supplier would need to know:

1. The conditions, with limits, both before and after the addition of the acid.
2. Information concerning rates of change of all the variables.
3. The relation of conductance to acid concentration over a range above and below the desired control point.
4. The volume of dilute acid required per unit volume of solution with respect to conductance or acid concentration changes over a range above and below the control point.
5. Pipe line sizes and materials.
6. The type of mixer contemplated and the possible lag resulting therefrom.
7. The nature of the material and its possible effect on the conductivity cell.
8. The pressure in the pipe line at the point of acid addition.

Heating of Process Material

Our process now requires the addition of heat to effect the desired chemical reaction in the presence of the acid catalyst. A shell-and-tube heat exchanger is indicated, with high-pressure steam as the heating medium. Fig. 7 shows the heat exchanger and the various items required to effect control of the temperature. It will be noted that although the incoming temperature is 120°F. and varies ±10°F., it is necessary that the material leaving the heat exchanger be maintained at 200°F. within ±1°F. This dictates the requirement for a highly refined type of temperature controller, so that changes in incoming temperature and rate of flow will not cause the outgoing temperature to deviate beyond these limits.

From the standpoint of the instrument engineer, the design of the heat exchanger is critical, since the degree of control which he can effect, to an appreciable extent, will be affected by the construction of the heat exchanger. For example, if the heat storage capacity in the shell is large, and the process material capacity in the tubes is small, it may be difficult to effect changes in heat transmission from the shell into the tubes at a rate sufficient to keep up with changes in the incoming material. Likewise, if the film coefficient of the material within the tubes is unfavorable, large changes in shell temperature may be required to effect small changes in the temperature of the process material. Building up of solids on the outsides of the tubes owing to the presence of impurities in the steam may result in changes in the controllability of the temperature over periods of time. Hence, considerable care should be exercised in selecting or designing the heat exchanger with regard to temperature-control requirements.

Even if the design of the heat exchanger is favorable, another factor may make adequate temperature control difficult if not considered prior to installation of the control equipment. For example, the drawing indicates that while the expected steam supply pressure will be 100 lbs./in.², variations may

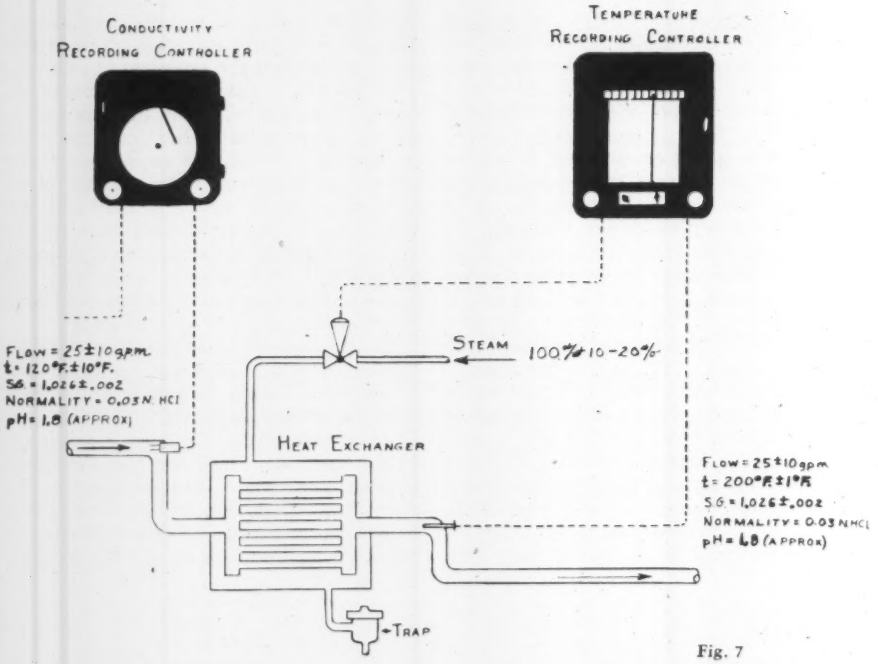


Fig. 7

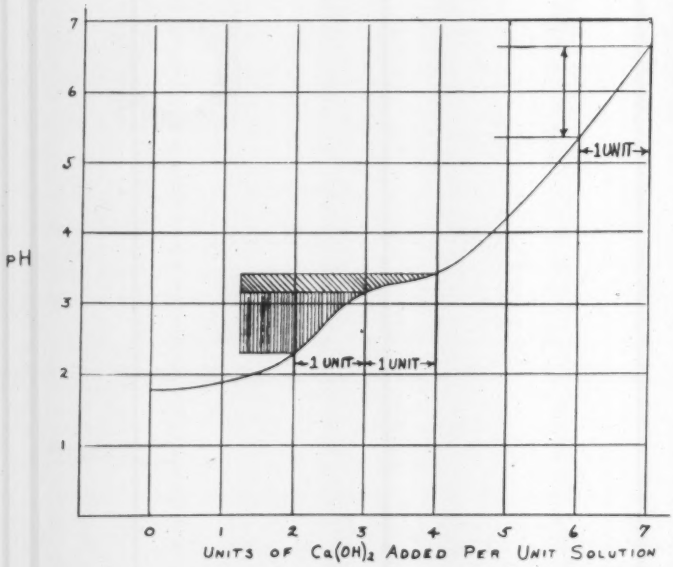


Fig. 8

be expected within the limits of 90 to 120 lbs./in.². If these steam pressure changes occur rapidly, the valve will be required to respond not only to process material changes, but to steam pressure changes as well, thus making satisfactory control difficult. A steam pressure regulator on the upstream side of the control valve would be indicated to reduce the effects of steam supply pressure changes. All too frequently, this factor is overlooked in an automatic-control installation, and most particularly where a heat exchanger is supplied from a process exhaust steam line. Then, the pressure drop across the valve is small and frequent changes in exhaust steam pressure reflect large changes in the quantity of steam which can be passed through the valve.

The possibilities of trouble developing from faulty steam trap operation should not be overlooked, as some types of traps cause frequent and unnecessary changes in back pressure within the heat exchanger shell.

Consideration of the problem indicates the need for a primary temperature-measuring element which will be both rapid in response and accurate in measurement with minimum hysteresis effect. Since the over-all measurement and control lag will have to be short, the measuring instrument, the control actuating element, and the valve operator, should be selected for fast response. The controller should have both proportional and automatic-reset functions, and an analysis of the control problem may indicate the need for derivative action as an aid in offsetting rapidly-changing incoming process material temperature or flow rate. Consideration likewise should be given to the characteristics of the control valve to make certain that the valve can produce changes in steam flow as demanded by the controller.

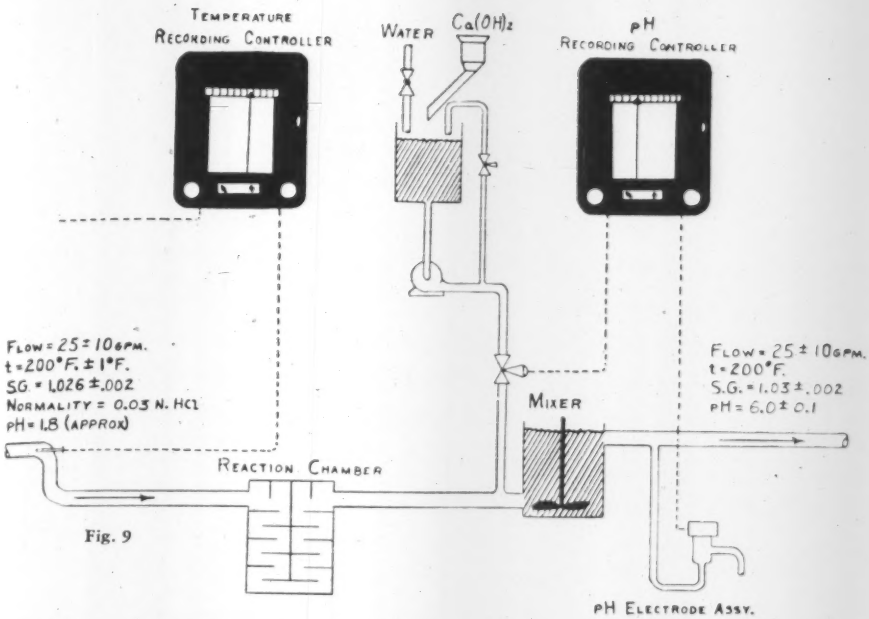


Fig. 9

As in the previous control application, an instrument supplier would need to have certain information:

1. The process conditions, with limits, both before and after the heat exchanger, as indicated on the drawing.
2. The rates of change of incoming material temperature and flow rate, and of steam pressure.
3. The calculated rates of steam flow required for maximum, normal, and minimum heat requirements.
4. The available pressure drop across the valve at maximum steam flow rate, which will depend on the supply steam pressure and pressure drops through pipe lines and heat exchanger, and back pressure imposed by the steam trap.
5. The process material pipe line size and material, and the pressure of the material within the pipe line.

Acid Neutralization

The chemical reaction produced by heating the material in the presence of the catalyst takes place in a reaction chamber following the heat exchanger. When the reaction is completed, it is necessary to neutralize the acidity, and it has been determined that lime is the best material to use as a neutralizing reagent. Since the acidity is to be neutralized, there is again an indication that pH may be used for detecting completion of the neutralization. A study of lime addition to the material versus pH provides the curve in Fig. 8. Here it will be noted that the rate of change of pH with lime addition is slow at the beginning. Then, after two changes in slope, the curve progresses with relatively slowly changing slope through the desired neutralization point. It is interesting to note that inflections in the curve cause pH to be sensitive to changes in lime addition between 2.3 and 3.2 pH, while from 3.2 to 3.4 pH, the measurement is relatively insensitive to lime addition. To control pH anywhere within this range might be difficult because of the burden imposed on the controller by the requirement for widely different rates of lime addition for equal changes in pH. At the desired control point of 6 pH, however, the curve indicates satisfactory use of automatic pH control. In further considering the use of pH as a means of detecting neutralization, it is important to take into account the possible effect of the material on the electrodes, particularly with regard to contamination or insulation of the surfaces of the electrodes.

Reference to Fig. 9 indicates a requirement for a pH end point of 6.0 ± 0.1. This calls for pH control within relatively close limits, and makes important the consideration of the process, the reagent addition, and the various control elements in the application of the control. Although it might appear desirable to introduce dry lime as the neutralizing reagent, considerable difficulty would be encountered in slaking the dry lime into the material on a pH basis. Likewise, the reaction of the dry lime with the material might be slow, thus introducing a reaction lag. It is preferable, therefore, to provide a milk-of-lime slurry sufficiently fluid to permit control with a valve. The density of the lime slurry probably should not exceed 2° Baumé. Because of the tendency for the lime to settle out, it is customary to recirculate the slurry from the bottom of the tank back into the top of the tank, withdrawing from the circulating line through the control valve only that amount required for effecting the desired pH control. The valve should be located as close as possible to the point of addition of the lime slurry and the lime from the recirculating system to the valve also should be kept short. Provision should be made for maintaining essentially constant the upstream pressure on the control valve.

Because of difficulties which may be experienced if the electrodes are installed in the mixing tank or in the pipe line, a sample of the lime-treated process material customarily is withdrawn from the system and passes through a small chamber in which the electrodes are mounted. This introduces a lag in detecting pH changes which must be considered in connection with the control problem. The possibility that the lime slurry will not react immediately with the process material would introduce another lag in the control system. These two lags, added to the measurement, controller, and valve response lags, generally make it mandatory to use a mixing tank which has sufficient capacity to swamp out effectively rapid changes in incoming material acidity or flow rate which cannot be handled by the controller. The size of the mixing tank will depend upon the rates of change of incoming material acidity and flow rate, upon the reaction lag between the lime and the process material, and upon the sampling lag. Its capacity will generally be from three to ten times the maximum flow per minute of the incoming process material and, since adequate agitation must be provided, the tank dimensions should be given study since minimum dimensions will minimize the cost of the agitator. It will be noted that the material flows in at the bottom of this tank and overflows near the top, thus providing a form of self-regulation of level.

The sampling line to the electrode assembly must be as short as possible, and provision must be made to recover the material which overflows out of the electrode assembly. The supplier usually provides an element in the electrode assembly which automatically compensates for changes in temperature of the process material by changes which it introduces in the electric circuit of the recorder.

As in the case of the two preceding controls, a recording controller having both proportional and automatic-reset functions will be required and, because of the greater lags in this system, the proportional sensitivity will be lower and the control action will be mostly automatic reset. It is important that the controller have provision for wide throttling range settings, possibly up to several hundred percent.

In order to make recommendations on control items and application, an instrument supplier would need the following information:

1. The process material conditions, with limits, both at the inlet and outlet of the mixing tank.
2. Information concerning rates of change of all of the variables noted.
3. The relation of unit volume of lime slurry addition to unit volume of process material with pH, including the effect of changes in acidity of the incoming material on this relation.
4. The nature of the process material and its possible effect on the electrodes.
5. The volume of the mixing tank contemplated, and the adequacy of the agitation which would be provided.
6. The rate of reaction of the lime slurry with the process material.

Addition of Solution "B"

Completion of the chemical reaction has formed certain precipitates in the process material which are filtered out on a continuous vacuum filter. A second solution must be added in volumetric ratio to the filtrate, and it is decided that the addition can be made on a flow

ratio controlled basis. This portion of the process is shown in Fig. 10. It will be noted that solution "B" is added to the process material at a flow ratio of 3:5.

Considerations concerning the measurement of the two flows are similar to those referred to previously in connection with the metering of solution "A." The flow ratio recording controller customarily has two pens, whereby the individual flows are recorded on the chart. The control action is such that changes in the independent flow will cause proportionate changes in the dependent flow. This is a relatively simple control application since the instrument responds rapidly to changes in independent solution flow and, by reason of high proportional sensitivity, rapidly operates the dependent-solution valve. It is desirable that solution "B" be supplied at constant valve upstream pressure. The characteristic curve of the control valve should be considered to make certain that changes initiated in the controller will result in the desired changes in flow-rate through the valve.

An instrument supplier would need to have the following information in order to make recommendations on equipment and the method of applying it:

1. The conditions, with limits, of each of the two flows.
2. The pipe sizes and materials, and the upstream pressure at which each of the solutions would be supplied to their respective flow-metering elements.
3. The nature of the two solutions and facts concerning whether they are clear solutions or slurries, and whether they are viscous or sticky.
4. Rate of change of solution "A" flow rate within the limits stated.

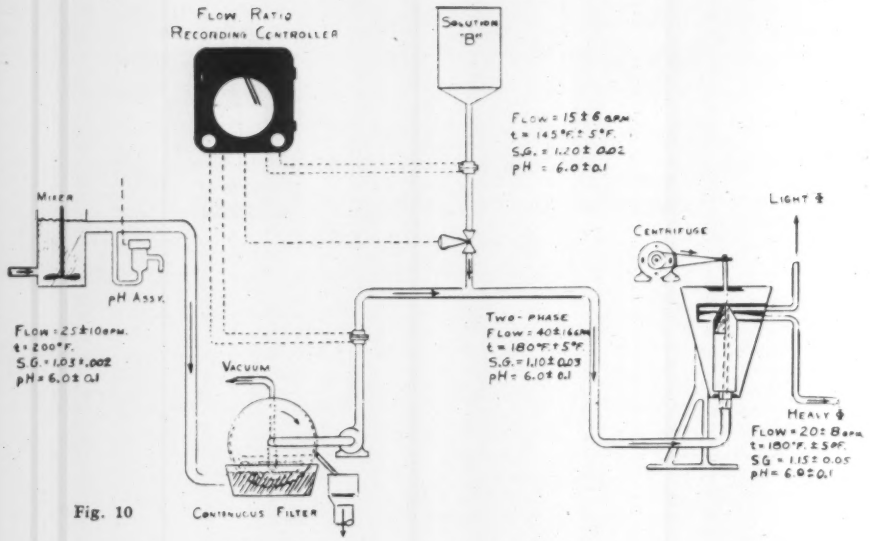


Fig. 10

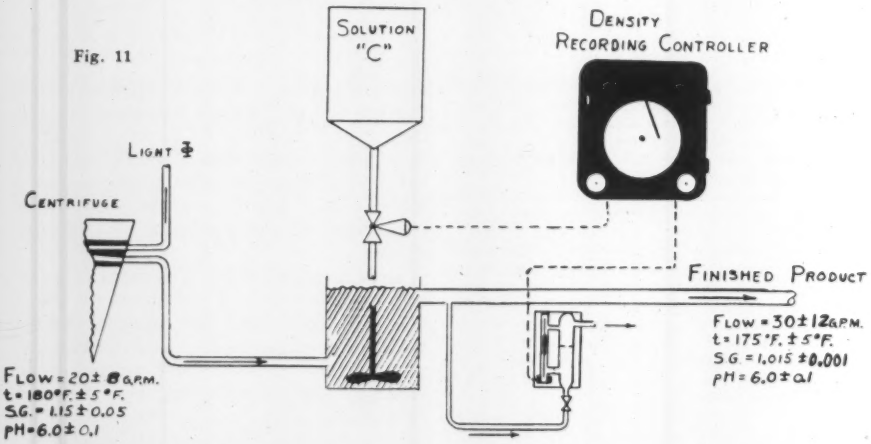

Solution "C"
Density Recording Controller
Light ϕ
Centrifuge
Finished Product
Flow = 30 ± 12 g.p.m.
t = 175°F. ± 5°F.
S.G. = 1.015 ± 0.001
pH = 6.0 ± 0.1
Flow = 20 ± 8 g.p.m.
t = 180°F. ± 5°F.
S.G. = 1.15 ± 0.05
pH = 6.0 ± 0.1

Fig. 11

Continuous Dilution to Finished Product Specifications

Solution "B" is immiscible with the process material, and the two phases are separated in a continuous centrifuge as shown in Fig. 11. We shall be concerned only with the heavier of the two phases. In order to obtain the finished product, it is necessary only to dilute the heavy phase with solution "C" to a fixed density. The finished product specifications call for a specific gravity of 1.015 ± 0.001, which necessitates consideration of all factors which may influence the closeness of control. It might appear that solution "C" could be added to the process material on a flow ratio basis, but it is indicated that the incoming material has a specific gravity tolerance of ±0.05. Control on a flow proportioning basis would not correct for incoming-material specific gravity variations. Hence, the control must be accomplished on a measured specific gravity basis.

There are on the market a number of instruments for measuring continuously the density of solutions. Some may be installed in a tank in which the material is contained, but more commonly the measurement is made outside the tank on a sample drawn continuously from the pipe line or tank containing the material. The measuring device should be selected carefully, since no available density-measuring device can be applied universally.

This control application is similar to the pH control application on the lime addition. Again we are confronted with a sampling lag (which may be even more severe). Changes in specific gravity of the process material with addition of solution "C" should be investigated over a range above and below the desired control point. Likewise, the effect of temperature on the measurement should be considered because of the required closeness of control. Most instrument manufacturers do not offer automatic temperature compensation with their density measuring devices, but at least one type of unit does incorporate such compensation.

The system lags dictate the use of a mixing tank of sufficient proportions to swamp out the effect of incoming-material flow-rate and specific-gravity variations. Adequate agitation of the material within the tank should be provided.

As in the previous applications, the control valve should be located close to the point of addition of solution "C" and the upstream pressure on the valve should be maintained reasonably constant. Both the incoming process material and solution "C" should be added to the tank in a manner that will eliminate the by-passing of either material directly into the overflow line without first being mixed with the other. The measuring assembly should be located so as to permit use of a short sampling line and the rate of sample flow should be high enough to minimize the sampling lag. Because of changes in rate-of-flow and specific gravity of incoming material, a controller with both proportioning and automatic reset functions again is indicated.

Recommendations on equipment and method of application by a supplier will require that the following information be available:

1. The conditions pertaining to the incoming material and the finished product with limits as indicated.
2. Rates of change of flow rate and specific gravity of the incoming material.
3. Normal temperature and specific gravity of solution "C" with tolerance limits.
4. Normal, maximum, and minimum rates of flow of solution "C" required to maintain desired specific gravity of finished product.
5. Relation of finished-product specific gravity to volume of solution "C" required per unit volume of incoming material for a range above and below the desired control point.
6. Nature of finished product and its possible effect on the measuring elements.
7. Units with which finished product density is to be measured and temperature to which measurement is to be referred.
8. Volume of mixing tank contemplated and adequacy of agitation to be provided.
9. Pipe sizes and materials, and upstream pressure on the control valve.

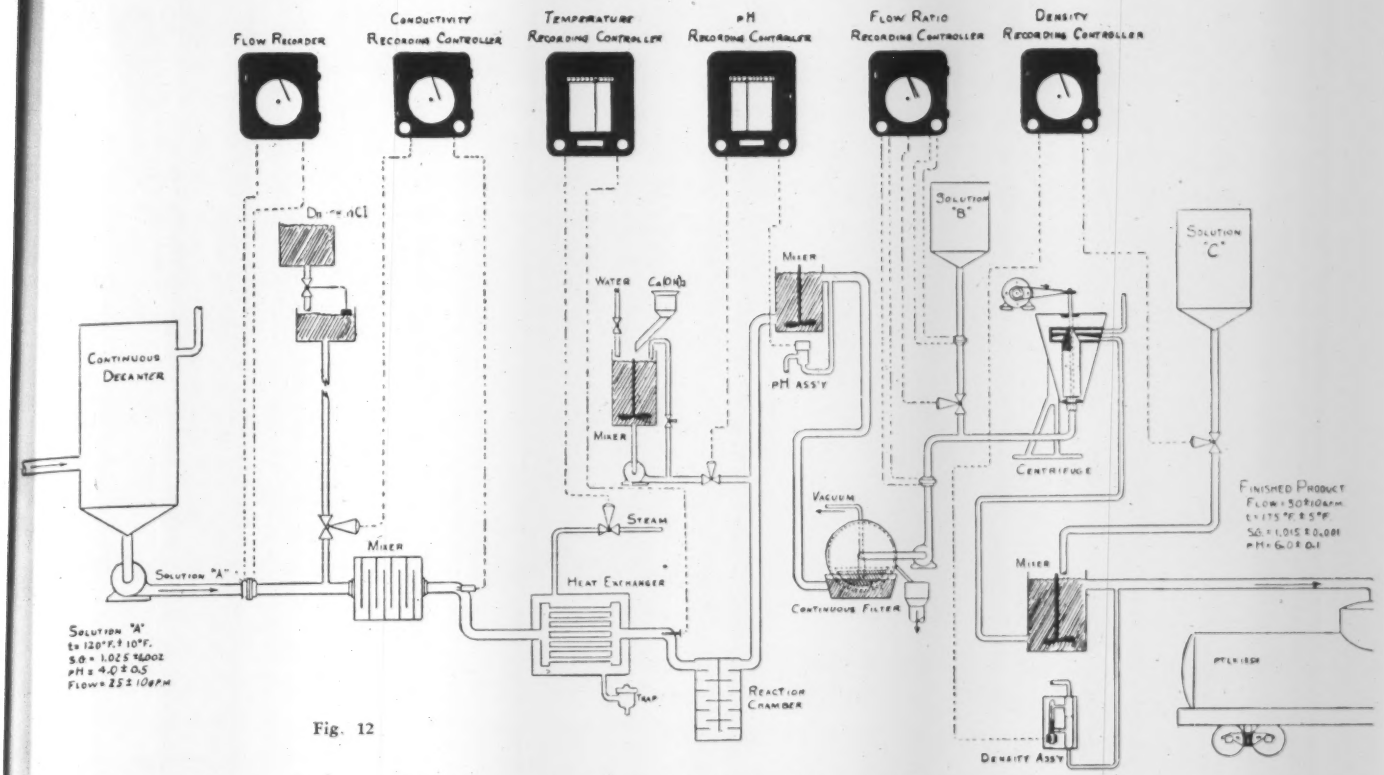


Fig. 12

Solution "A" has been treated in a series of steps in a continuous process to provide the required finished product. Reference again to Fig. 1 will indicate the continuous-pipe-line form of process layout which was contemplated by the process engineer before the use of instrumentation was considered. Fig. 12 shows the completed process with all of the process equipment and all of the instrumentation. Although we have deviated from the desired form of pipe-line control, the requirement for finishing the material in a continuous process has been met and means have been provided for maintaining the several variables within the required limits.

Conclusion

In summarizing the problems encountered in the application of instrumentation to a chemical process, several conclusions can be drawn which may be stated in the form of "Don'ts."

1. Don't wait too late to contact the instrument application engineer when considering the design of a new process because much of your work may have to be redone when the instrumentation engineer has introduced his requirements to obtain the closeness of control which you require.

2. Don't overlook the necessity for considering carefully all of the details concerning the application of the instrumentation when preparing layout drawings. It is often helpful to include any necessary instructions on the drawing concerning points of particular importance in regard to installation.

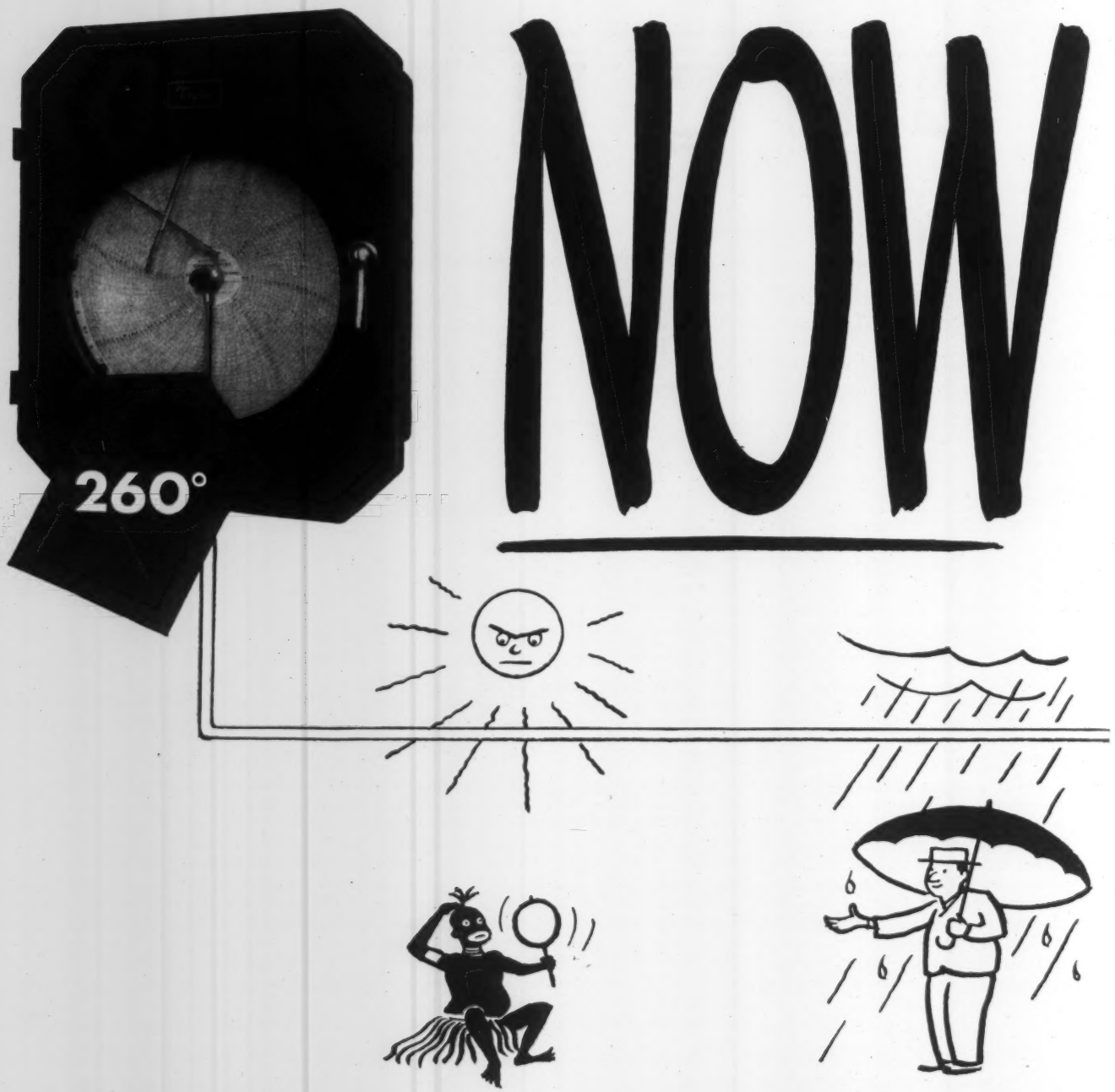
3. Don't overlook the necessity of careful follow-through at the time the instrumentation is being installed in the plant. Construction men are not generally familiar with the details of instrument installation and unless your instructions are unusually explicit, they will find a way of making the installation in such a manner as to cause future trouble.

4. Don't expect to get optimum results from the automatic-control equipment on the first day it is in operation. It usually is better practice to start the whole process under manual operation and permit the operator to become acquainted with the various adjustments which are later to be made automatically. He will have greater respect for the instrumentation if he is given an opportunity to regulate the process initially by hand and learn some of the difficulties resulting from lack of constant attention on his part to all of the factors influencing the closeness of control of his finished product. Considerable care should be given in the adjustment of the various control functions to make certain that the controllers are given an opportunity to produce the results of which they are capable.

5. Don't expect an operator who has operated processes manually for a number of years to accept automatic controls without some misgivings. He does not know the capabilities of modern instrumentation and a good deal of patience must be exercised in your efforts to get him to help rather than to hinder the successful operation of the instrumentation.

6. Don't expect your operators to take pride in your instrument installation if you have just hung the individual instruments indiscriminately on any convenient wall or post. They should be installed on a well-designed panel, with each instrument and control station located from the standpoint of operating procedure. The panel should be placed near the operator's normal location. The present trend is toward centralization of all instruments and controls in a single location for an entire process, with sufficient indicated and recorded information on the panel to permit the operator to tell at a glance exactly what is happening in all parts of his process. The inclusion of manual-operating stations at the panel so that each of the control elements may be remotely hand-operated from the panel will be of distinct advantage to the operator.

7. Finally, don't expect that a well-thought-out process layout incorporating modern instrumentation properly applied and then properly installed finishes your work. Unless provision is made for intelligent maintenance of all instruments on a regular routine basis, you cannot expect to obtain optimum benefits. In many processes, failure of an instrument to perform its functions satisfactorily will result in loss of product, lower quality, and sometimes in danger to the operators and process equipment. Hence, the instrument maintenance supervisor should be a man with long experience, with knowledge of chemical process operations and of the various reactions taking place, and he should have sufficient breadth of understanding to be respected by both the operating personnel and the company management. It is important too that instrument maintenance be separate from all other forms of maintenance, and that the instrument maintenance supervisor be responsible to someone with influence in the organization. Such a program will result in preventive rather than curative maintenance with little likelihood of actual breakdown of any equipment in operation.



REMEMBER the toothpaste manufacturer who advertised, "We couldn't improve the cream, so we improved the tube"? Well, we never thought we could improve the quality of Taylor Accuratus Tubing. It featured a built-in compensation for temperature variations between the point of measurement and the instrument case. And this extended the many advantages of the mercury actuated system to applications requiring long lengths of connecting tubing.

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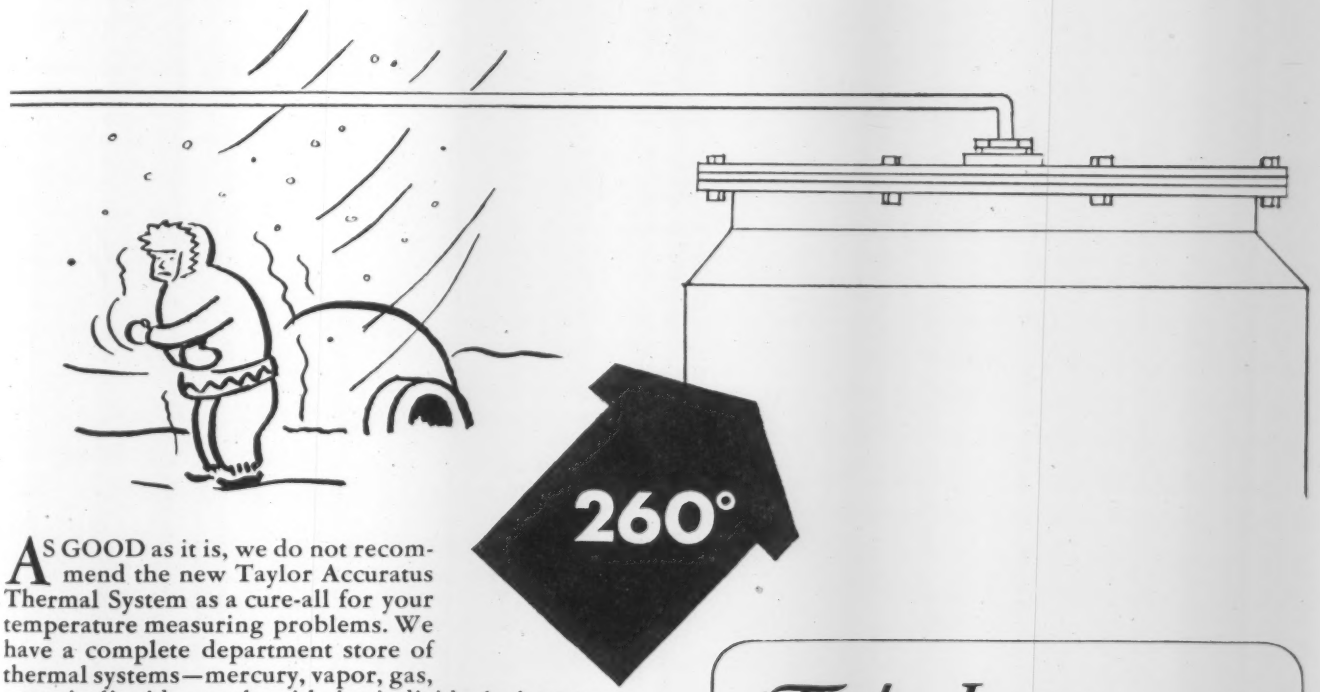

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▾ ▾ ▾

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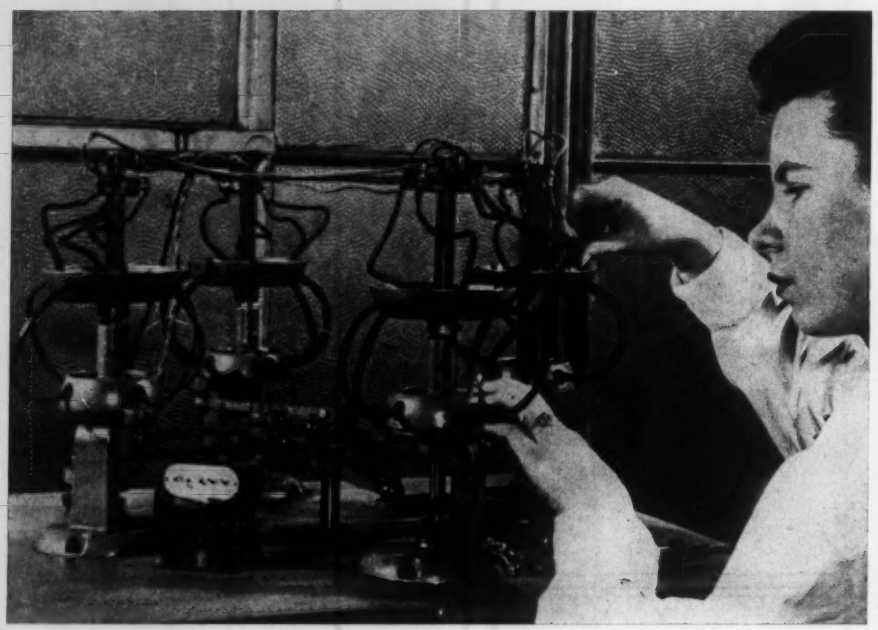
INSTRUMENTS ON THE MARCH



Automatic "Twist Tester" for Electric Cords

EAST SPRINGFIELD, Mass.—In order to select the electric cord that will best do the job, engineers at the Westinghouse works here have built a robot tester which will simulate the conditions of twist to which a cord on an oscillating fan will be subjected, or similar to those for a cord on an electric iron or vacuum cleaner.

The testing machine consists of four post-like shafts mounted in a square atop a wooden box. Each post runs through the center of a pair of metal rings to which foot-long sections of the cord to be tested are attached. These rings on each shaft are connected by eccentric arms to a motor-driven vertical member in the center of the square. The arms push the rings 90° in opposite directions, giving 180° total twist, or twice the normal amount when the cord is attached to the fan.

The cords are twisted at the rate of 160 oscillations per minute (32 times normal fan speed). Each cord carries a current which actuates a counter. A "twist-life" value for the cord can be determined from the reading on the counter and from the calculated oscillations for the life of the fan.

To answer the problem posed by the effect of time on the cord, an aging chamber was devised. The cord to be tested is bent into a U shape and inserted through holes in a board. Powerful ultraviolet rays are concentrated on the projecting U section of the cord in a chamber where temperature, humidity, and oxygen are controlled. These four factors deteriorate the cord in a period of hours in much the same way that exposure in a room would cause deterioration over a period of years.

By combining the age resistance properties and the "twist-life factor, the cord best suited for the job can be selected. This is not necessarily the best cord, but is rather the least expensive cord which is guaranteed by the test to last as long as the fan itself.

New Traveling-wave Tube Tops All Range-width Records

NEW YORK CITY.—An entirely new and yet surprisingly simple vacuum tube amplifier which may be of far-reaching significance in long distance telephone and television transmission was revealed recently at the Institute of Radio Engineers' Microwave Conference at Yale University by Dr. J. R. Pierce of Bell Telephone Laboratories (shown in photo).

Preliminary tests indicate that the tube may amplify dozens of full color or black and white television programs simultaneously—should anyone want to send that many at once. Or it might theoretically handle more than 10,000 simultaneous cross-country telephone conversations or over a hundred million words a minute by telegraph—if there's any desire for that.

Over the past three decades in which amplifier engineers have had the vacuum tube to work with, considerable progress has been made in developing tubes and associated circuits capable of amplifying wider and wider bands of frequency. For example, a band width of about 10,000 cycles at the beginning of the period has been broadened to one of about 20 megacycles today.

Now the new Bell Laboratories tube, breaking sharply with the past, promises to amplify voice or television signals over a frequency band forty times as wide as that of the best tube now in use and to give many times the amplification.

Conservative figures for the new Bell Laboratories tube show a power gain of 10,000 times over a band width of 800 Mc. By comparison, the present pentode tube can give a power gain of only 10 times over a band width of 20 Mc., and a velocity-modulation tube, operating in the microwave range, gives the same amplification over a band width of 10 Mc. Engineers believe that even the above figures for the new tube can be improved for it has by no means reached its full development.

In addition to these contributions to wide-band amplification, the tube is remarkably simple (see photograph). An entire amplifier hook-up, of which the tube is the heart, occupies a space less than two feet long and a few inches square and it can do the work of a maze of tubes and circuits.

The idea underlying the tube, known as a traveling wave tube was proposed and was worked on during the war by a British scientist, R. Kompfner of Oxford University's Clarendon Labora-

tories. Dr. John R. Pierce of the Bell Telephone Laboratories, with Dr. L. M. Field, has solved the electronic problems of the new tube and overcome effects which rendered earlier efforts of little practical value. Together with F. H. Best, who has handled mechanical design and construction problems, they have produced a practical device.

The principle of the tube's operation is entirely different from previous type amplifiers. The essence of the tube is a long helix of thin wire, running from one end of the long stem to the other. The wave to be amplified is fed onto the helix at the bulb end—an electron gun—through a wave-guide and then drawn off at the other end in the same way.

The wave travels along the coiled wire at the speed of light but, because of the winding of the wire, it moves along the length of the tube at only a thirteenth of this speed. Meanwhile, from the electron gun, a beam of electrons is shot down the inside of the helix in the same direction the wave is moving and at approximately the same speed, i.e., one-thirteenth the speed of light.

The speeds are not exactly matched, however, and on the average the electrons go faster than the wave. They tend to slow down, though, and in so doing, they give up some of their energy to the wave. As a result the wave gains a tremendous amount of energy and is many times amplified.

The picture is not unlike that of a breeze blowing past ripples on a pond—the ripples grow larger as the breeze blows them along. In the tube, the electrons "blow past" the wave on the coil and *reinforce* the wave by transferring energy to it.

World's Usable Oil Resources Increased by "Miniature Oil Field" Instrument

PITTSBURGH, Penna.—An electrically-operated miniature oil field, which will benefit the aviation and other industries by saving immense quantities of oil that otherwise would be lost beneath the earth's surface, was announced by Gulf Oil Corporation. The new instrument will substantially increase the world's usable oil resources by foretelling, with considerable accuracy, just what will happen in an oil-producing area for periods up to twenty years in the future.

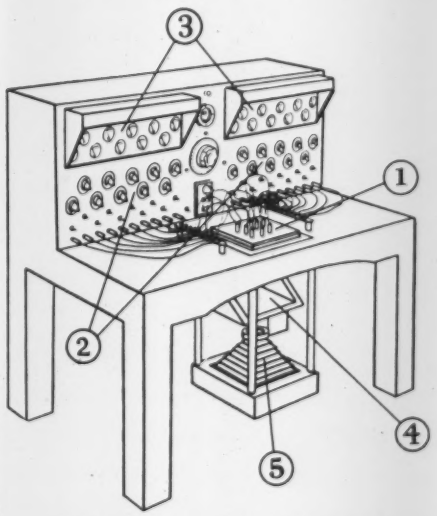
Physicist H. G. Botset, of Gulf Research Labs, plans oil production on the Electrolytic Model Oil Field he invented. The instrument duplicates actual oil field operations on a laboratory scale, to foretell results of various production methods, assuring scientific advance planning and a greater percentage of oil recovery. The young lady assistant holds a tray of miniature "oil wells."

From such forecasts, oil production may be planned so as to force to the surface a greater percentage of the oil reserves hidden in the earth than was previously practical.

The "Electrolytic Model Oil Field," as the instrument is christened, was pioneered by scientists of Gulf Oil Corporation's Research Laboratory at Harmarville, Penna. Already in practical use, it is making possible greater oil production from existing fields, and contributing to the economy of oil production.

Maximum oil extraction is achieved by the ability of the Electrolytic Model to gage exactly how water flooding or gas injection operations may be conducted without blocking off from the wells part of the oil reserve, so that it does not flow to the surface.

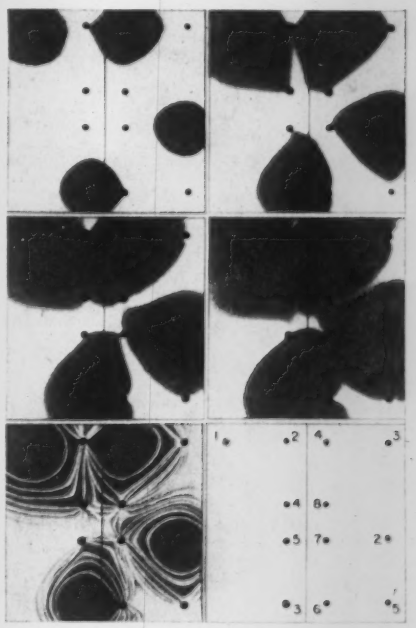
The accomplishment of the Gulf Research scientists, who developed the Electrolytic Model, lies in the utilization of the flow of electric current so that it can measure and predict the flow of water, gas and oil within oil sands. In the instrument, miniature wells—actually small tubes connected with an electrically sensitized mat—are set up in the same relation and at proportionate distances as in a given oil field. Current is fed into the sensitized mat, which represents the oil field. By recording the slow spread of this current through the mat, a picture is given of how water, gas or oil would spread beneath the field.



Simplified sketch of the Electrolytic Model Oil Field. (1) plastic tubes representing input and output wells; (2) control knobs which adjust the flow, in or out, for each well. The flow is indicated by the electrical instruments (3). Beneath the wells a tilted mirror (4) enables the operator to view the progress of the flow pattern, while a camera, (5) records the flow in pictures.

From this picture, these salient facts are learned: How much oil can be produced from the field, and consequently the most efficient plan for operations. For instance, the flow pattern shown in the picture aids in determining the location and number of wells, the desirable rate of flow per well, and the amount of water and gas needed. Procedures for coming years may thus be planned more exactly, and will secure a greater oil yield than has heretofore been possible.

Previously, water and gas injection plans were based primarily on estimated porosity and saturation of the sand, from which forecasts could not be as dependable. Now, when scientists temper data from the Electrolytic Model with their information on the geological structure of particular fields, final deductions show considerably improved accuracy. The instrument can represent a field of up to twenty wells.



The four upper photos show the progressive spread of water from injection wells toward the producing wells, represented by black dots. Note that water does not reach all producing wells at same time. In the fourth photo water has reached all wells, indicating that further injection will not force more oil toward these wells. The blank areas remaining at this stage are considered "blocked off" from the producing wells; and new input or output wells must be sunk to recover oil in these areas. The left bottom photo tells the same story in one composite picture of the various stages of flooding. Bottom right shows how the field appeared before the laboratory flooding operation began. In addition to the black dots for producing wells, circled dots shown here indicate the injection wells which are obscured from view after the flow begins.

Portable Air-sampler for Counting Bacteria

CLEVELAND, Ohio. — Development of a portable electrical air sampler, designed to help mankind wage effective war against disease-spreading airborne bacteria, has been announced by General Electric Company at Nela Park, Cleveland.

Capable of revealing a reasonably accurate count of microbes in the air at various times and places, the new instrument (Fig. 1) serves as an indispensable companion tool to the G-E germicidal lamp. About the size of a shoe box and weighing but 12 pounds, it was developed by Dr. Matthew Luckiesh, head of lighting research laboratory at Nela Park, and two of his colleagues: A. H. Taylor and L. L. Holaday. They call it the Duplex Electrostatic Air-sampler.

Armed with the sampler, air-probing engineers may now readily determine two important facts about flying microbes and germicidal radiation. They may accurately compute the amounts of germicidal energy needed to keep airborne bacteria reduced to a minimum for human safety. They may also use the new electrostatic instrument to check the effectiveness of germicidal lamp installations.

The air sampler makes its debut at a time when the war against airborne bacteria is receiving nationwide attention. Keeping pace with this spreading interest is the growing demand for germicidal lamps on the part of householders, hospitals, schools, theaters, restaurants, other commercial establishments, and industry.

Equipped with an electrically-driven blower, the new air sampler "inhales" air at the rate of half a cubic foot per minute. Static electricity is used to attract the positive and negative germ-laden air particles out of the air stream. The sampler develops highly-charged electrostatic fields. The attracted air particles are intercepted by petri dishes coated with a nutrient jelly. This jelly traps the airborne microbes much the same as house flies are caught on sticky flypaper. Fig. 2 is a sectional diagram of the sampling instrument.

The bacteria captured on the petri dishes are then incubated for about forty hours at a temperature most favorable to their growth. Quantitative and qualitative bacterial counts are made from the white fuzzy germ colonies which appear, by the end of the incubation period, on the nutrient jelly.

Comparative tests made in theaters show that the bacteria catch is four to five times greater when the duplex sampler was used with the electrostatic feature in operation than when it was turned off.

Put to use in a cafeteria, the sampler revealed that the average number of organisms per cubic foot of air during the lunch period was 27. The maximum number varied from 44 to 88 per cubic foot of air. After the cafeteria had been emptied of its people, the bacteria count dropped down to 15. (See Figs. 3 and 4.)

In a theater with a large audience, with a medium amount of air per person and with the air exhausted outside, average concentration of bacteria was found to be only 7 organisms per cubic foot of air. This figure jumped to 32 when a similar test was made with the new sampler in another theater with a large audience present but with a small volume of air per person. Most of the air in the latter theater was cooled and recirculated.

All of which naturally poses the question: what does the new sampler reveal about the germ-killing effectiveness of germicidal lamp installations? Early tests made in a germ infected poultry-house showed that an existing system of germicidal lamps reduced the number of airborne bacteria more than 75% after so little as an hour's treatment of the air. These tests, according to the designers of the sampler, are being extended to include germicidal lamp installations in the human field. Up to now, Luckiesh and his aides have concentrated much of their effort on perfecting the G-E portable duplex electrostatic air sampler device.

Fig. 1. Dr. Matthew Luckiesh inserting a bacteria-free petri dish into the new portable electrostatic air sampler.

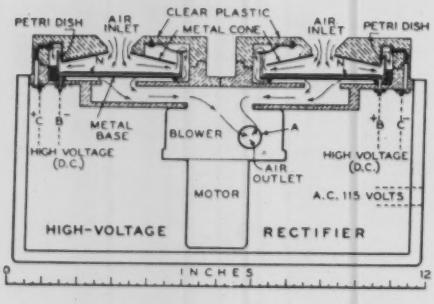


Fig. 2. The diagram here shown is a vertical section of the duplex electrostatic air sampler.

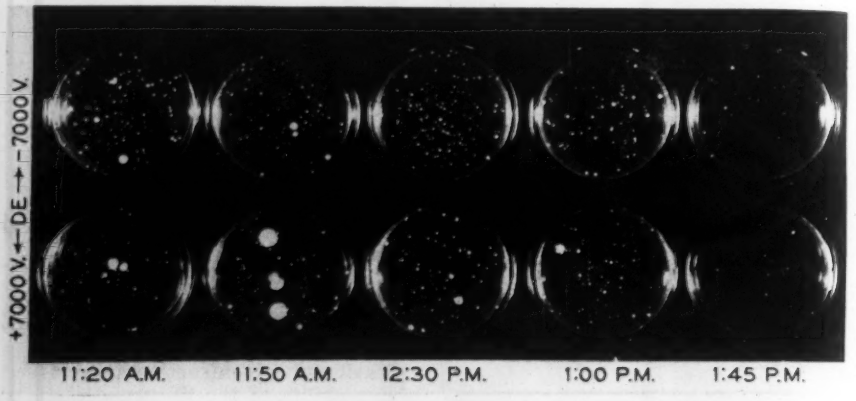


Fig. 3. This photo shows the populations of bacteria grown on jelly-coated petri dishes after the new electrostatic air sampler was used in a cafeteria of high occupancy, from 11:20 a. m., to 1:45 p. m. The upper row of petri dishes represents the positive air particles attracted to the jelly; the lower row represents the negative germ-laden particles attracted. Note how few bacteria colonies formed in the two dishes at the extreme right. These were exposed after most of the people had left the cafeteria.

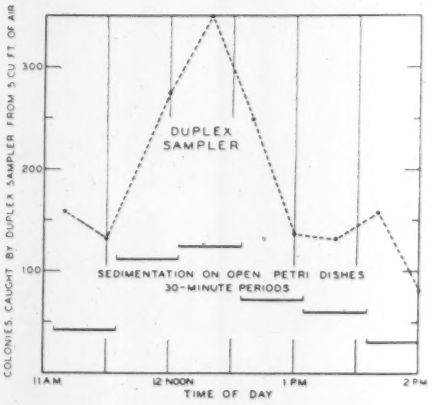


Fig. 4. This chart shows the variation in concentration of airborne organisms in a cafeteria before, during, and after period of high occupancy.

Hydraulic Operation and Electric Control Utilized in Conveyorized Multiple-spindle Pneumatic Gage

DAYTON, Ohio.—An automatic instrument for simultaneously gaging bore diameters of an automobile cylinder block at 32 points for GO and NOT GO and proper classification has been built by the Sheffield Corp. for the Buick Division of General Motors. The entire gaging job takes less than 60 seconds.

Designed expressly as an integral part of a production line, this multiple-spindle "Precisionaire" checks for diameter, taper and out-of-roundness of eight cylinder bores of an engine block at four different points in each cylinder, and classifies them to 0.0003".

The engine blocks are brought to the gage by the conveyor line, then checked, and passed down the line to the next operation. The cycle begins with one block in loading position. As the starting button is pressed, loading arms pick up the block and advance it to the gaging position where two hydraulic plungers locate and hold the block.

Now perfectly aligned, the eight cylinder bores are entered by eight spindle assemblies which elevate automatically. Each assembly consists of four spindles that float independently to allow for tolerances in hole spacing. Upon reaching the limit of travel, the spindle automatically stops and can be manually rotated through 180° for out-of-round inspection. The spindles may be stopped at any point and rotated 180°, if so desired. If interference is encountered by any one of the sets of spindles, the machine stops and a red light indicates the incorrect cylinder bore.

Thirty-two "Precisionaire" indicating tubes are grouped and located at eye level. Each of the eight spindle assemblies has four tubes to indicate its findings. A scale graduated in 0.0003" and marked off in selection sizes of numbers from 1 to 10 is located to the right of the right-hand tube in each set.

As the engine block is being gaged, the floats fall in the tubes to a position opposite a number on the scale. The movable tolerance slide is positioned to determine if all four floats are within the out-of-round and taper limits which are 0.0007". If so, the selection size is indicated by the number opposite the float in the right hand tube. This number is then manually stamped on the engine block directly beside the cylinder bore so classified. Stamping of the selection size of each bore is accomplished by a marking device mounted directly above each of the eight spindle assemblies.

Fig. 1 shows an operator setting the minimum tolerance limits of the four right-hand tubes with the minimum master. Fig. 2 is a close-up of a motor block in gaging position with the eight spindle assemblies inside the cylinder bores.

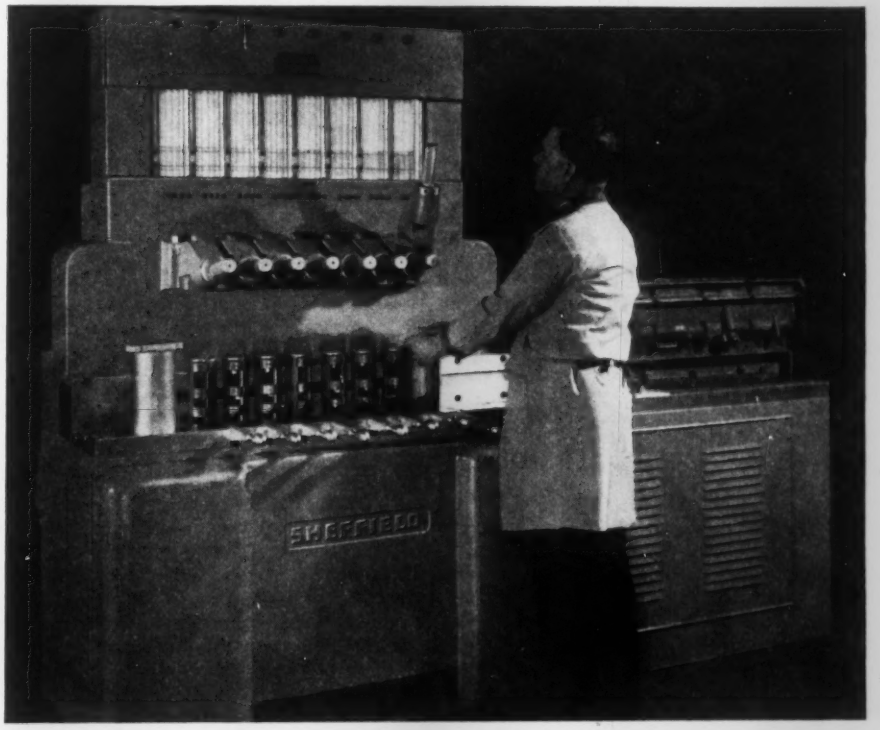
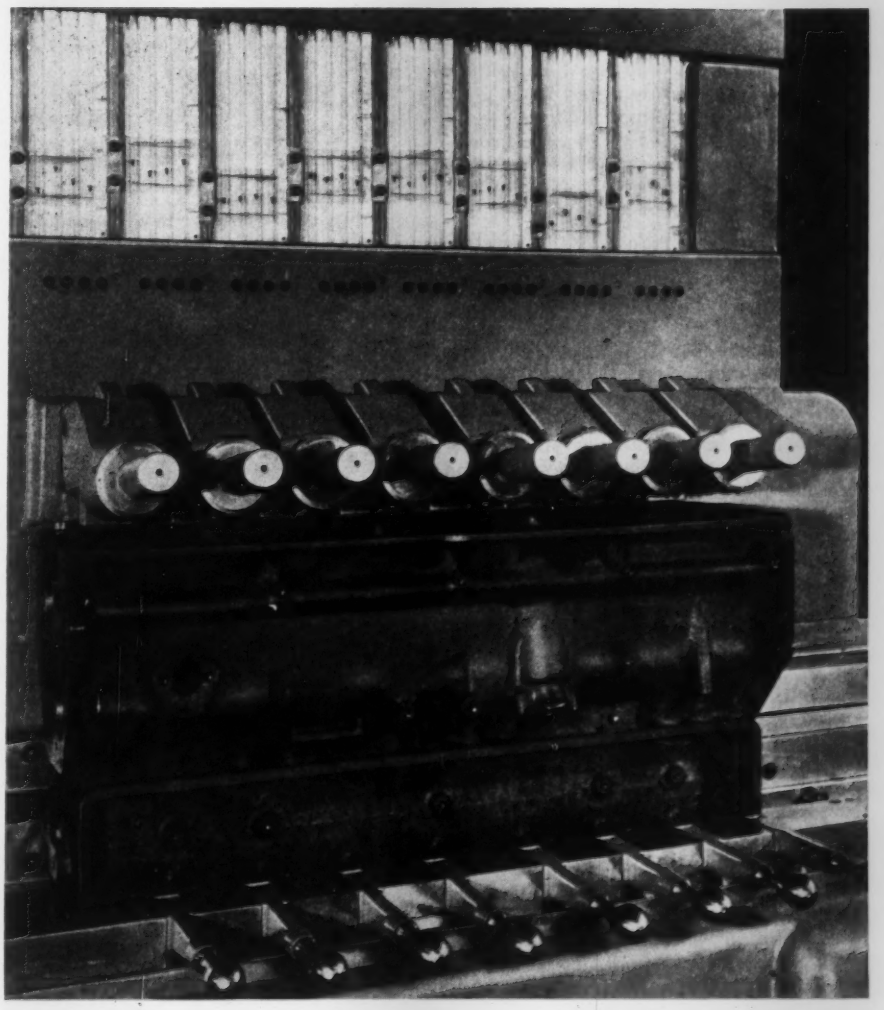
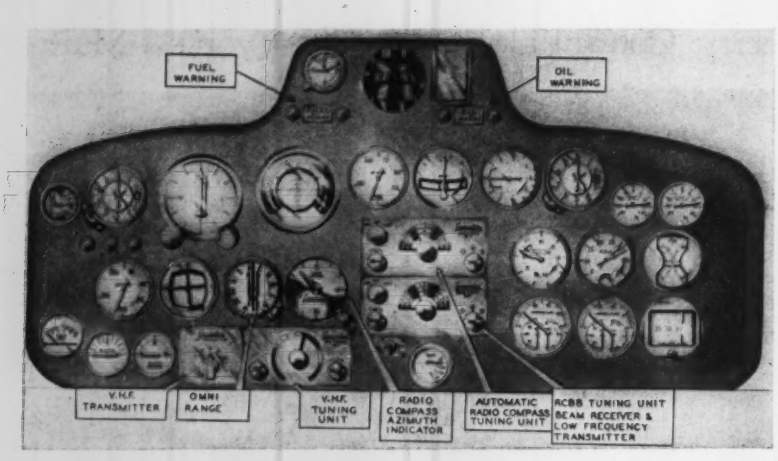


Fig. 1 ↑ Fig. 2 ↓





"Ideal" Aircraft Instrument Panel Embodies Advice of Airline, Military and Private Pilots

GRAND RAPIDS, Mich.—William P. Lear, president of Lear, Inc. designer and producer of aircraft radio and navigation instruments over the last fifteen years, has designed an aircraft instrument panel that has efficiency as well as beauty as its foremost aims, with a resultant design that will undoubtedly influence instrument panels of personal as well as commercial aircraft.

The airplane for which this panel was designed is a Beechcraft Model 18, which Mr. Lear personally flies on his business trips between the Lear plants in Grand Rapids, Mich. and New York and Hollywood offices. Features embodied in this new design concern group-of most important flight and navigation instruments in direct view of the pilot, avoiding the overhead shelf arrangement for radio equipment which makes the pilot reach, or turn, or bend backward to operate his sets. Everything is conveniently placed where it can be readily seen and reached.

"The final choice of the best radio and instrument arrangement to give optimum service under all flight conditions was based on the consensus of airline, private and military pilots visiting our plant who placed templates on a blank panel of the type used in my new Model 18 Beechcraft to signify the preferred grouping," Mr. Lear stated.

In determining the best arrangement, the veteran pilots stressed certain basic groupings. Navigation and power plant instruments should be located for convenient reading; radio equipment placed in direct view and within easy reach for tuning. Accordingly, Mr. Lear designed his instrument panel so that radio equipment, flight and navigation instruments are directly in front of the pilot, easily checkable without moving or twisting.

The selection of radio equipment for this panel represents an optimum choice especially adaptable for the radio communication and navigation requirements during the interim period of the change-over of the airway facilities to operate on VHF. It includes the Lear three-band Model ARC-10 Automatic Radio Compass that can be used for low-frequency long-range radio navigation with the RCBB three-band receiver as an auxiliary unit. Provisions have been made for manual operation of the ARC-10 loop antenna in connection with the RCBB unit.

One feature of the ARC equipment is the extremely simple loop antenna that consists of a small (approximately 4") loop rotated by a simple mounting "H" drive mechanism.

Another feature is the servo unit with combination dynamotor, power supply and gear attachment with clutch arrangement that will automatically rotate the loop to the usual null position when tuned to any particular station. In connection with the operation of the VHF transmitter-receiver, there is, of course, the very light-weight and extremely simple VHF transmitting and receiving antenna. If, and when, it is deemed advisable, a VHF *cross-reed* blind-landing indicator can also be used. The weight of the new ARC-10 equipment is the lowest available. It is expected that the total weight of this automatic equipment will be in the neighborhood of 20 lbs.

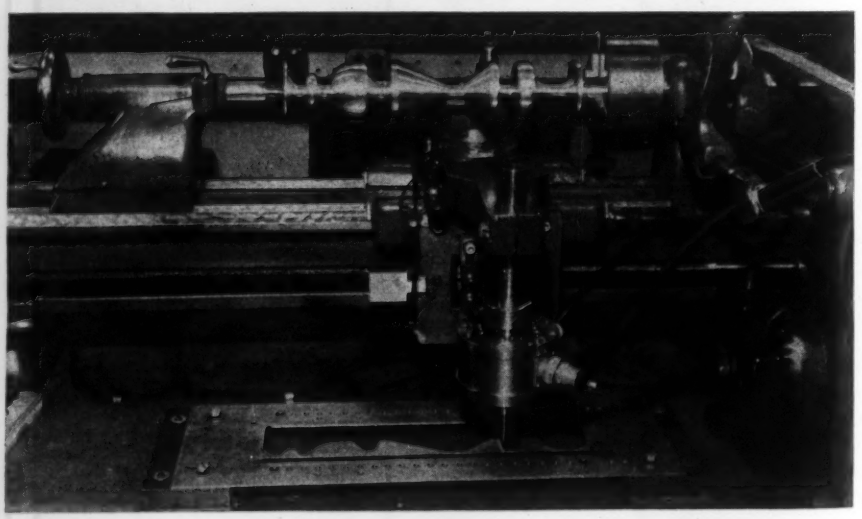
There is also a five-watt five-frequency Lear VHF transmitter, the companion unit to which will be the VHF tuning unit for the receiver. The third component is a combined rf. amplifier, second detector audio amplifier, modulator and power supply.

The engine instruments are on the right-hand side of the Lear panel, quite visible when there is need for checking, but not cluttering up the pilot's vision when he should be watching flight and navigation instruments.

The panel described and pictured here is the one selected as the best after a dozen or more layouts were tried; and suggestions and comments from dozens of pilots gathered. Work on this panel was done in the Lear Aircraft Radio Service Shop at Grand Rapids.

A Contouring Controller with a Sense of Touch

SCHENECTADY, N. Y.—Almost anything that can be cut with a motor-driven tool from a pattern or template can be produced accurately and completely automatically by a machine equipped with a new automatic contouring control system which literally has a "sense of touch," it was announced by the General Electric Co. The tracing stylus (foreground in photo) comprises two magnetic bridges mounted on right-angle axes, providing the necessary signals for control of two feed motors. When a change in pattern contour is encountered by the stylus, the motors change speed simultaneously as required to reproduce the same contour on the work in the machine (the lathe in the background). These speed changes are so controlled that the motion of the tool across the work is continuous and at a constant rate. The tool marks are equally spaced regardless of the direction in which the tool travels.



If a 90° angle is encountered, the direction of pressure on the stylus and the direction of motion are changed by 90° almost instantly. Either an inside or outside angle can be cut in this manner. The necessarily fast motor control is attained through use of a thyratron tube. The master control panel has provisions for remote non-automatic operation of the contour equipment, the operator merely pushing a button to take over operation.

Machines equipped with such control turned out many complicated parts for turbosuperchargers and jet engines during the war.

"One-man" Centralized Drilling Control for Oil Well-drilling Rig

PITTSBURGH, Penna.—Ease of operation, safety, and speed of drilling are features of the heavy-duty mechanical drilling rig designed by Oil Well Supply Co., United States Steel subsidiary. Based on five years of experimental work, this new rig is capable of drilling to 16,000 feet with 3½" drill pipe or 12,000 feet with 4½" drill pipe. All controls are conveniently located at the driller's position (see Fig. 1) and respond to finger-tip control.

The major units included in this complete rig are a No. 96 draw works unit or hoist, rotary table, 400-ton swivel, six-sheave 350-ton crown block with companion five-sheave traveling block, a 7¾" × 20" main and a 7¼" × 18" auxiliary slush pump, and three internal-combustion engines capable of delivering 1000 hp., plus the necessary transmission equipment and accessories.

All control levers and instruments are mounted on a central panel similar to that found in a modern airplane cockpit (Fig. 2). Small hand levers actuate air valves which control operations of the draw works, drive, rotary pumps, and sand reel. The three engines are similarly controlled by hand throttles in the panel and can be operated either singly or in compound. For hoisting, control may be shifted to a foot pedal. Air-operated friction clutches to the rotary and automatic cathead on the rotary side are controlled by foot pedals at the base of the central control panel.

On the main control panel are mounted instruments to show air pressures, engine vacuums, transmission-shaft speeds and oil pressures.

Field experience proves that this new rig is particularly adaptable to all deep-drilling areas. The power supply under sensitive quick-acting control is of value in hard-rock drilling where the number of round trips per well runs high. The convenient centralized finger-tip control eliminates the former back-breaking labor in controlling drilling. Units now in operation are setting new records.

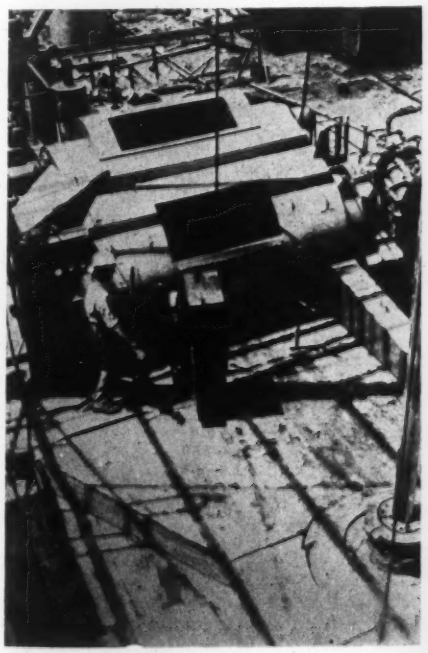


Fig. 1

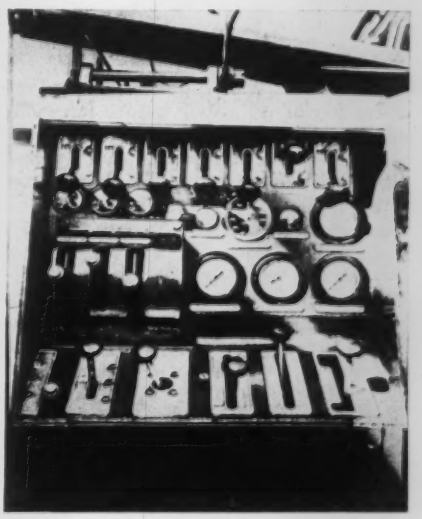


Fig. 2

WHEN A FELLER NEEDS CONTROL BY Putt
INSTRUMENT DEPARTMENT? GET A MAN OVER HERE RIGHT AWAY - YOUR DARN METERS ARE OFF! WHAT'S THAT - ANY LEAKS AROUND? NAW - NOT A LEAK ON TH' JOB. EVERYTHING CHECKED A YEAR AGO, SO IT MUST BE THE METERS!
CHIEF OPERATOR LEAKAGE DIVISION-A
IDEA BY: RALPH GIVENS BETHLEHEM STEEL CO BETHLEHEM, PA.

SECOND of a series of cartoons which we hope will add to your enjoyment of *Instruments*. In order to make this truly your own feature, send us your ideas. (You have had experiences which were aggravating at the time but good for a laugh later.) *Instruments* will pay $5.00 for each idea used. Ideas should be presented in words and should not mention any specific manufacturer's equipment or trade name. In case of similarity, payment will be made to the writer of the suggestion bearing the earliest postmark. Sender's name and company affiliation will be acknowledged in the cartoon unless we are specifically requested not to do so.

Scientific Glass Blowing and Laboratory Techniques

By WILLIAM E. BARR and VICTOR J. ANHORN, Gulf Research & Development Company

IX. PRODUCTION OF HIGH VACUUM *(Continued)*

Oil Condensation Pumps

Condensation pumps designed for mercury cannot, in general, be used with oil. C. Burrows[9] has given three main features in design which render mercury condensation pumps unsuitable for oil.

1. The clearance between the jet and condenser is too small, causing oil to bridge the gap when the pump is in operation.

2. The vapor lines leading to the jet have cross-sectional areas which are not large enough to allow an adequate supply of vapor for efficient pumping.

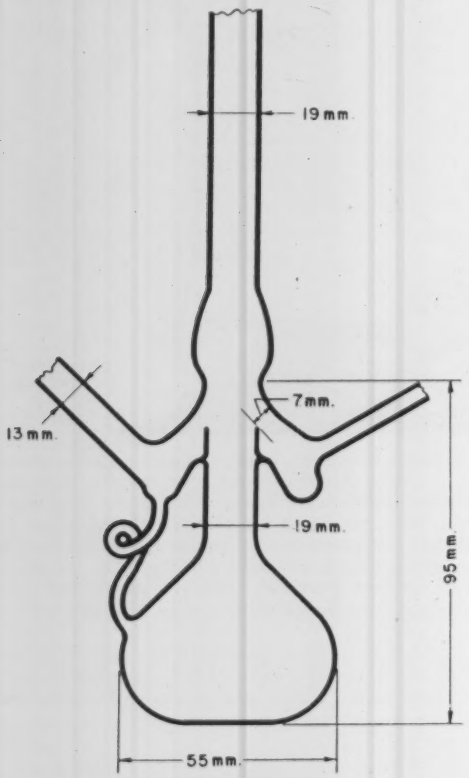


Fig. 112

3. The jet and vapor lines run too cool and cause condensation of oil vapor before it reaches the effective pumping area.

Oil condensation pumps must therefore be designed with a larger space between the jet and condenser. The minimum width is $\frac{3}{32}$". The vapor lines must be large and preferably short to permit adequate vapor flow and to prevent excessive condensation.

Oils for condensation pumps can be readily obtained. Apiezon oils which are specific fractions of a petroleum oil were developed by C. R. Burch[11] and are supplied by the James G. Biddle Company, Philadelphia. Oils similar to Apiezon oils can also be obtained from the Litton Laboratories, Redwood City, Calif., and from the Central Scientific Company, Chicago. An extensive study of numerous organic compounds with high vapor pressures was made by Hickman and Sanford[12], who found that di-*n*-butyl phthalate and butyl benzyl phthalate were satisfactory. Octoil, which is superior to di-*n*-butyl phthalate was developed by Hickman[13]. The latter two oils, along with butyl sebacate amiol, amoil S and Octoil S, are supplied by the Distillation Products, Inc., Rochester, N. Y.

Certain precautions must be observed in using oil condensation pumps. The oil must not be overheated because of the danger of decomposition. Overheating will result if the heat input to the oil boiler is too high, if the oil is not cooled sufficiently before it returns to the boiler, or if the backing pressure is too high. It has been found convenient to use electrical heaters on the oil boilers and it has been found that small coiled heaters which directly contact the oil are best from the standpoint of heat input by definite wattage values. A boiler of this type will be illustrated in Fig. 116B.

The assembly of glass oil condensation pumps will not be given in detail because the techniques required have already been discussed in the preceding articles. Critical dimensions will be given and, if special assembly techniques are required, these will be described.

One of the early oil condensation pumps designed and tested by Hickman and Sanford[11] is illustrated in Fig. 112. The main assembly feature of the pump is the inverted ring seal. The boiler had a diameter of 55 mm. and the jet and outlet tubes were made of 19-mm. tubing. The high-vacuum inlet was made of 13-mm. tubing. A clearance of 7-mm. was allowed between the jet and condenser surface.

The speed of the pump which contained di-*n*-butyl phthalate was 6.5 liters per second when the condensing surface was not cooled by moving air. This speed was increased to 7 liters per second when the condensing surface was cooled with moving air. The watt inputs at the two speeds were 32 and 45 respectively. It was found that when copper wire was looped about the condensing surface, excellent thermal transfer was obtained.

Oil condensation pumps differ from mercury pumps in that permanent gases and vapor which are pumped are slightly soluble in the pumping oil. If no provision is made to segregate the lower-boiling, contaminating liquids or products of decomposition of the pumping oil, the pumping efficiency of the pump decreases. The pump shown in Fig. 113 is designed to make use of the fractionating principle for eliminating the contaminating materials from the last stages on the high vacuum side of the pump. As well as other pumps of this design, this pump is supplied by Distillation Products, Inc., Rochester, N. Y. The physical and operation data of this pump are given in Table 16.

TABLE 16

PHYSICAL AND OPERATION DATA FOR TYPE 6F25W THREE-STAGE WATER-COOLED FRACTIONATING PUMP

High vacuum connection	27 mm. I.D., 30 mm. O.D.
Forepump connection	
Vertical	Sealed off
Horizontal	22 mm. I.D., 25 mm. O.D.
Height, inches	13
Length, inches	25
Width, inches	5
Construction	Pyrex Glass No. 774
Weight, oz. net	48
Amount of oil, gms.	200
Recommended oil	Octoil-S
Forepressure, mm. of mercury	0.10
Heater Power, watts	90–250
Heater Current, amperes	1.4–2.3
Heater Voltage, A.C. or D.C.	65–108
Speed, liters per second	25
Ultimate Vacuum, mm. of mercury at 25°C.	5×10^{-8}

The forepressure required for this pump at various heater inputs is given in the graph of speed versus forepressures in microns (1 micron = 0.001 mm. mercury), Fig. 114. For vacuum in the order of 10^{-6} mm. mercury, the forepressure

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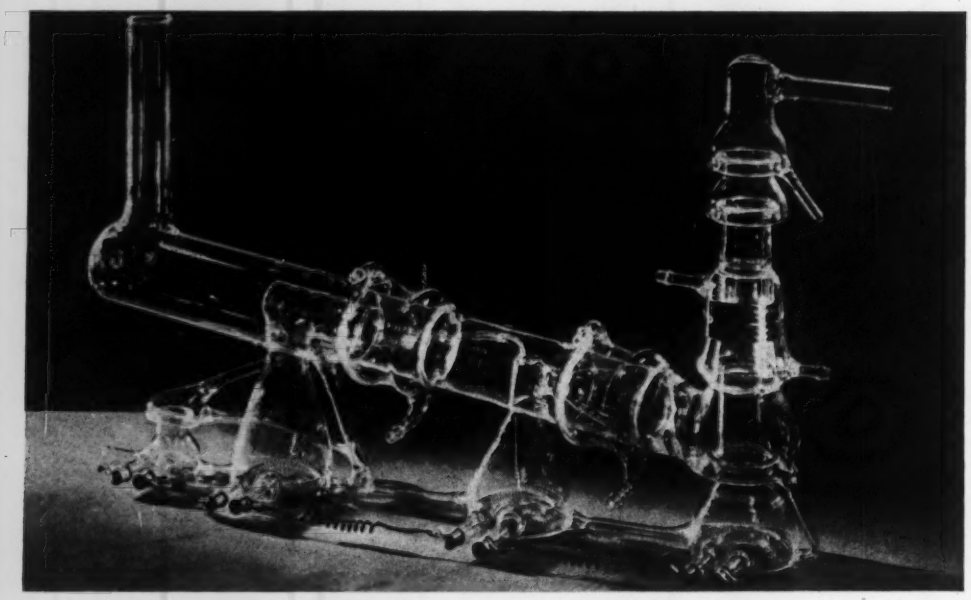


Fig. 113

must be not more than 30 microns with a heater input of 1.5 amperes.

Speed versus high vacuum at various heater inputs is given in the graph of Fig. 115. The speed is constant over a wide range of pressure. A vacuum up to 10^{-6} mm. mercury can be obtained in a short time. The ultimate vacuum of 5×10^{-8} mm. mercury can be obtained when Octoil-S is used as a pumping fluid. No liquid air trap is necessary. It is desirable, however, to have some sort of baffle arrangement to prevent oil molecules from leaving the pump. A right-angle bend of the low pressure side of the pump, Fig. 113, is satisfactory for preventing oil escape.

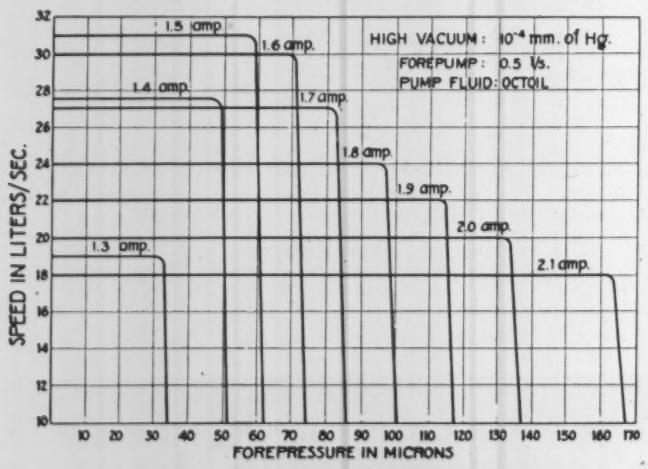
The boilers of this pump illustrate a feature which has become quite popular for oil pumps. The heating coils which are immersed in oil (the oil level is preferably ¼" above the top of the coils) give uniform heating with a minimum amount of oil. Large surface area allows sufficient vaporization area with a minimum amount of oil, thus reducing the mount of oil decomposition in each boiler.

A small oil condensation pump designed by C. H. Bachman[14] is illustrated in Fig. 116. This pump was designed for a portable electron microscope and because of its size, can be used where small pumps are required. It can easily be set up in a 6" × 6" × 3" space. The pump is fitted with a ball-shaped baffle, and the tube leading to the backing pump is at a 7° angle to allow for oil drainage, should any get into the tube. A 3-mm. clearance between the beveled jet and condensing surface is recommended. The high-vacuum inlet is bent in two right angles to prevent back flow of vapor. The pump is charged with 35 cc. of oil. Each boiler is insulated to prevent heat fluctuations. The heater on the high-vacuum side of the pump is made by coiling 0.018" nichrome wire, 78" long, on a ⅛" mandrel. The heater on the low-vacuum side is made of a 62" length of the same wire. The glass-to-metal seals can be made in many different ways. Four methods which have been used are the following:

1. A small Kovar cap with one hole in the bottom is sealed to the Pyrex Glass No. 774 boiler with a graded seal as described in the preceding chapter. The coil heater with two straight ends is then positioned in the boiler and the straight ends are passed through the holes in the Kovar cap. The heater wires are soft-soldered to the cap. Small clamps which snap over the caps can be soldered to the power lines.

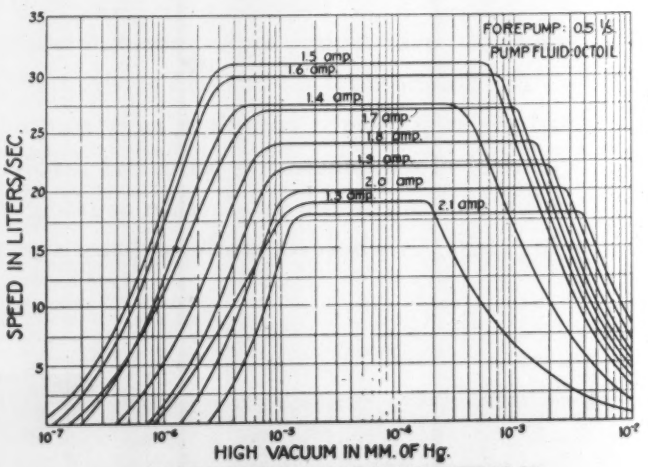
2. Tungsten rods with copper braided wire on one end can be beaded and sealed into a flare. This flare is then sealed to the boiler through a graded seal after the heater coil is spot-welded to the tungsten rods. The Pyrex Glass No. 774-to-tungsten seal has been described.

3. It is sometimes convenient to seal the tungsten leads



GLASS THREE-STAGE PUMP TYPE GF-25
SPEED VS. FOREPRESSURE

Fig. 114



GLASS THREE-STAGE PUMP, TYPE GF-25
SPEED VS. HIGH VACUUM

Fig. 115

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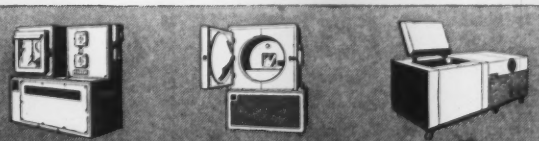

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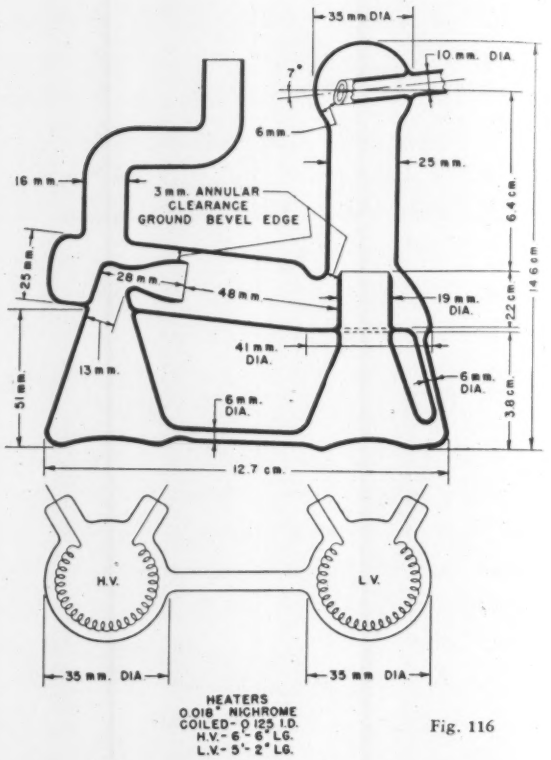

Fig. 116

through glass by a glass press seal technique. Two wires can be sealed in one operation.

4. A tungsten rod is partly covered with a thin sleeve of 7051 glass. A Pyrex Glass No. 774 bead is made over a

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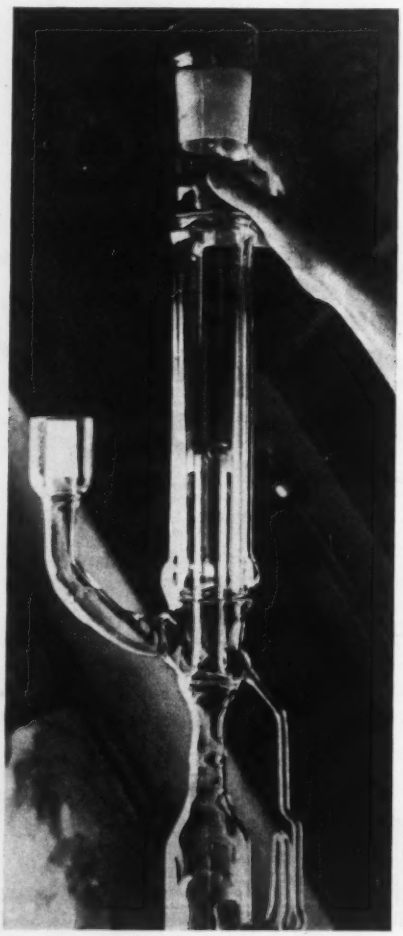

Fig. 117

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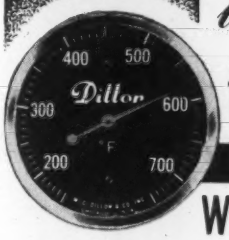

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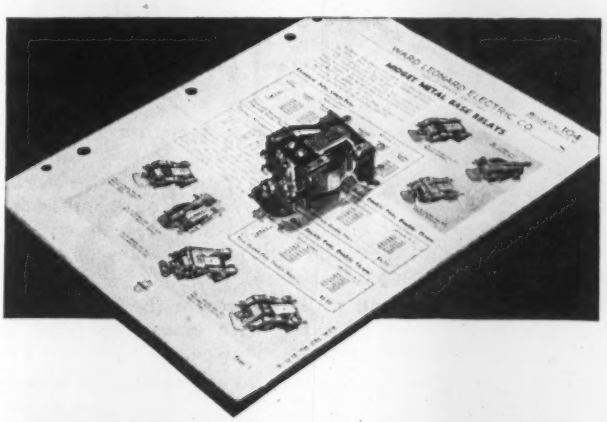

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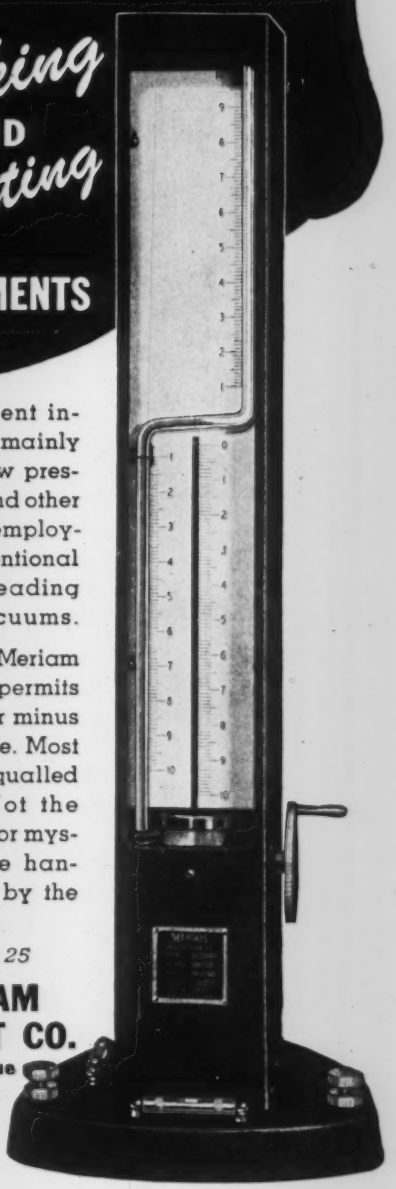

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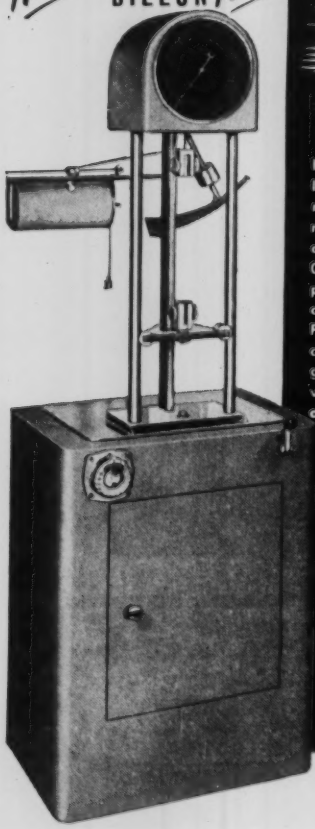

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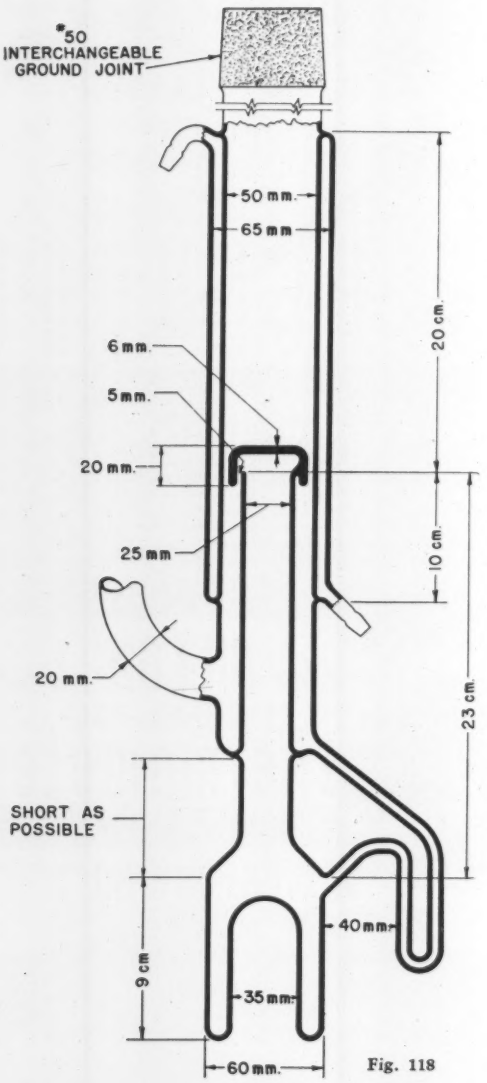

Fig. 118

part of the glass sleeve by fusing a thin rod to the sleeve and winding the fused rod on the sleeve until sufficient glass is collected for the bead. This bead is then sealed into the open end of the boiler side arm after the heater coil is spot welded to the tungsten rod.

The usual arrangement of the heater in the boiler is as illustrated in Fig. 116. If a two-wire glass press seal is used, only one boiler side arm is required.

An umbrella jet oil condensation pump designed by Estermann and Byck[10] is shown in Fig. 117. The pump is shown with mercury seal ground Standard Taper joints. The detailed drawing of the pump is given in Fig. 118. The pump is assembled in a manner similar to the mercury pump previously described. The vapor line and umbrella jet, however, must be inserted through the top of the pump when the bottom ring seal is made.

The pump was tested with butyl phthalate and a pumping speed of 15 liters per second was obtained. The backing pressure required for this speed is 0.07 mm. mercury.

Traps

Traps are necessary for preventing the migration of mercury vapor into evacuated systems when mercury condensation pumps are used. The trap design of Bull and Klemperer has already been discussed and the advantage of this design, especially in a kinetic system, is that effective trapping is obtained without obstructing the gas flow from the high-vacuum system. However, the conventional traps, Fig. 119, still can be used quite effectively in small vacuum systems where speed of evacuation is not the prime requisite.

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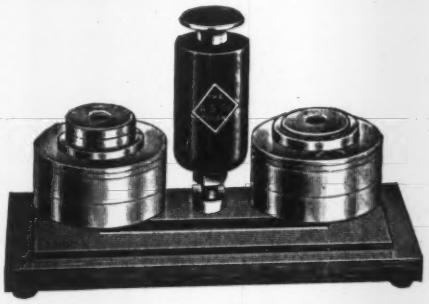

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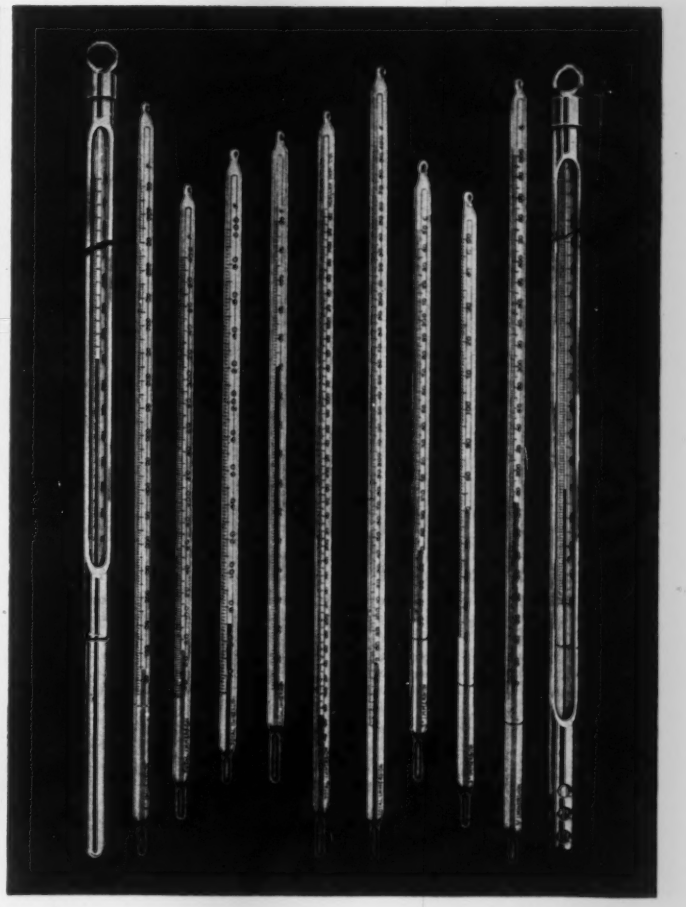

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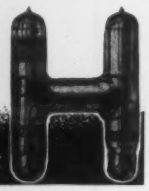

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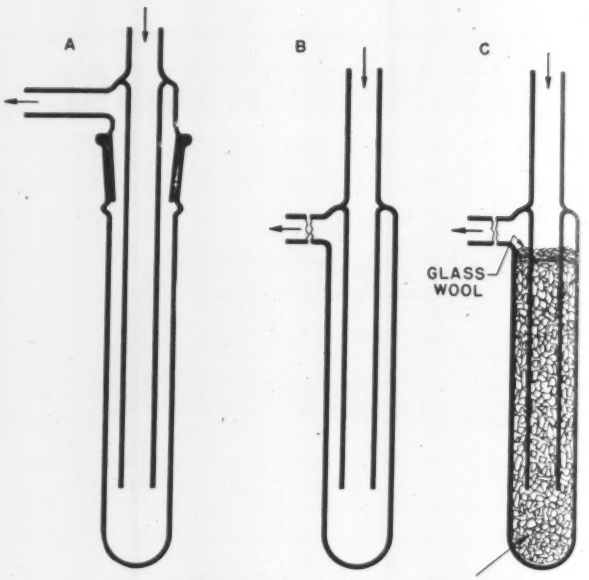

Fig. 119

The traps should be made with clearances in the order of 15 mm. The trap in Fig. 119A has a ground glass joint and should be used only when the trap must be cleaned frequently. The ground joint must be carefully lubricated. The conventional traps are illustrated in Fig. 119B and Fig. 119C. The latter is packed with granular activated charcoal, which, because of its absorptive properties, is quite useful for preventing mercury vapor diffusion, as well as absorption of residual gas. The charcoal can be reactivated by heating it to 800°C. while it is maintained under vacuum. The absorbing power of charcoal according to Dewar[15] is given in Table 17.

TABLE 17
ABSORPTION CAPACITY OF COCONUT CHARCOAL
Volume of Gas at Standard Conditions of Temperature and Pressures per Unit Volume of Charcoal

Gas	*At 0° C.*	*At −185° C.*
Helium	2 volumes	15 volumes
Hydrogen	4 "	135 "
Argon	12 "	175 "
Nitrogen	15 "	155 "
Oxygen	18 "	230 "
Carbon Dioxide	21 "	190 "

The traps shown in Fig. 119 are immersed in a refrigerant contained in a Dewar flask to insure condensation of vapors. Liquid air is frequently used and, if the trap is in

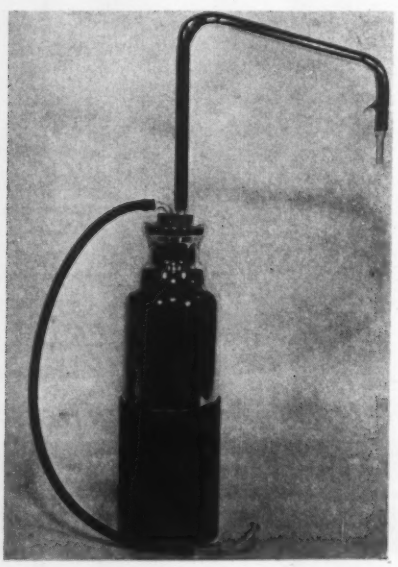

Fig. 120

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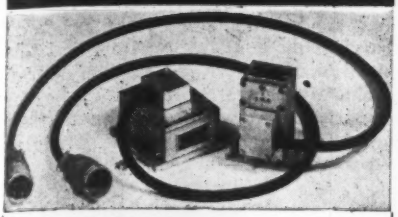

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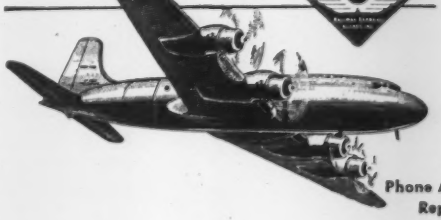

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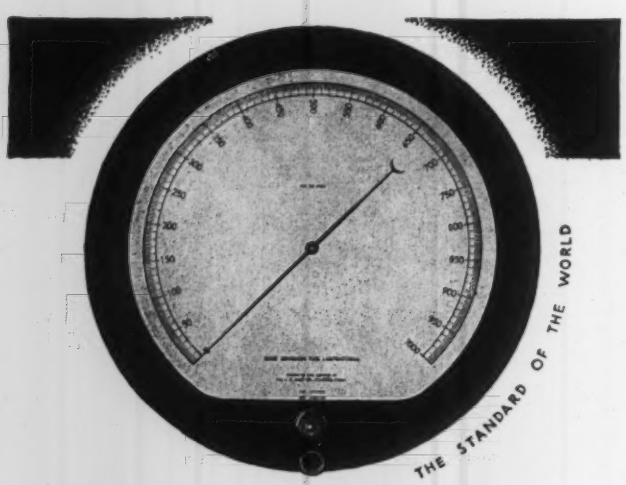

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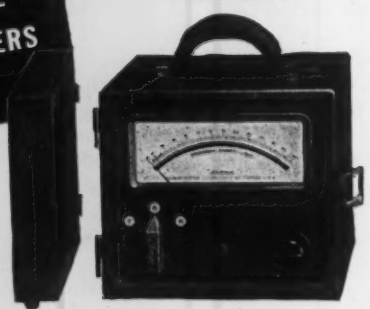

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continuous use, it is desirable to have some means of supplying refrigerant to the trap Dewar. The vacuum-jacketed delivery tube shown in Fig. 120 is connected to a Dewar by a stopper. Air pressure applied to a blow line in the stopper forces the refrigerant through the delivery tube.

The delivery tube ring seals are made by the procedure outlined for simple straight-tube condensers. Only one side-arm tubulation is required on the outer jacket. The delivery tube is bent after the ring seals are completed by heating the outer tube at the desired point with a hot bushy flame until the outer and inner jackets are quite pliable. The glass is annealed and allowed to cool. The jacket is then silvered and evacuated.

Oil condensation pumps do not require elaborate traps when vacua up to 10^{-6} mm. mercury are required. Simple

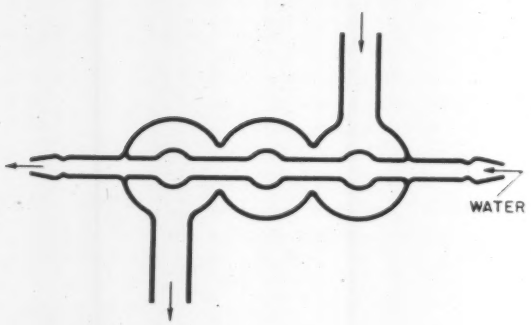

Fig. 121

baffles or right angled bends in the high vacuum inlet of the pump have been successfully used. A trap designed by Hickman[16] for use with oil condensation pumps is shown in Fig. 121. The trap is cooled with water and is quite effective in preventing back-diffusion of oil vapors.

Matching Rotary Vane and Condensation Pumps

Rotary vane oil pumps have definite pumping speeds at various pressures. It is necessary to know these speeds or the pumping characteristics over the pressure range which includes the backing pressure required by the condensation pump. In Fig. 99 the speed of the Welch Duo-Seal pump 1405 at 0.1 mm. mercury is 0.35 liters per second. If this pump is to be used with a condensation pump which requires a forepressure of 0.1 mm. mercury, the speed of the latter pump must not be greater than 0.35 liters per second when measured at the outlet side of the condensation pump. The speed on the high-vacuum side will be greater because of the lower pressure. As an example, suppose the condensation pump operates at a speed of 25 liters per second at 0.001 mm. mercury. This speed as measured on the outlet side of the pump is $(0.001 \times 25)/0.1$ or 0.25 liters per second.

The Welch Duo-Seal pump 1405 would be a satisfactory backing pump for the condensation pump cited in the above example, for under the pressure conditions, this rotary vane oil pump is capable of pumping 0.35 liters per second. However, if the Welch Duo-Seal pump 1400 is used, which under these pressure conditions pumps 0.175 liters per second, the speed of the condensation pump is reduced because the backing pump is not able to move the gas fast enough.

To be continued

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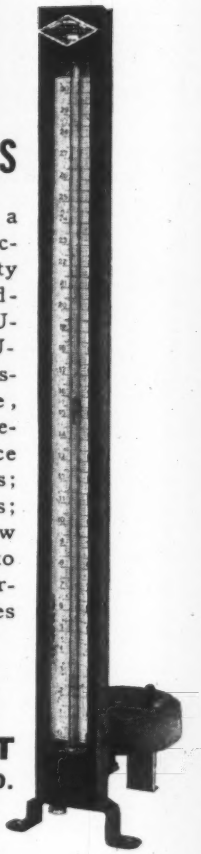

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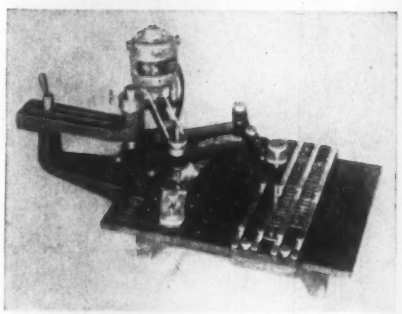

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New "Type V-10 Variacs" fill obvious gap between conventional 5-ampere and 20-ampere adjustable autotransformers. 115-volt models are rated at 10 amperes, with a 15-ampere maximum, coinciding with capacity of commonly-used outlets, plugs,

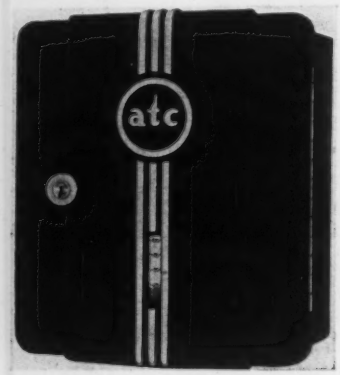
cords, and No. 14 wire lines. Designed for most favorable distribution of copper and iron, with low-loss core material and lightweight structural parts, "Type V-10 Variacs" deliver from 60 to 100% more kva. per pound than older models; also have improved brush and construction features of "Type V-5," previously announced (see *Instruments*, August 1946, page 482). Output voltage continuously variable from zero to 17% above line voltage. New units are available in 6 models, 115-volt and 230-volt service.—*General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.*

Please mention number 1002 when filling out card

Input Controller for Electric Furnace Temperature Control Systems

New "Type 4701 Electronic Balancer Input Controller" may be quickly installed on any existing electric furnace temperature control system to provide automatic compensation for load variations (also known as "droop correction" or "automatic reset"). Basic principle involves balance of one slide-wire in existing potentiometer and another slide-wire in new instrument. Overshoots are said to be prevented when heating up a cold furnace, when a cold charge is entered, or when load is exceptionally light. Addition of this new instrument to conventional furnace temperature control system provides "proportional plus floating" mode of control and is said to assure closer control and reduce electric power costs. Furnace production is said to be increased because an input indicator on front panel (graduated 0-100% input) informs operator just when work is "at heat" and thus enables him to measure soaking time accurately. Among other features is an adjustment making it possible to reduce the capacity rating of an electric furnace, saving power and permitting adaptation of hardening furnaces to drawing and close control of hardness values.—*Automatic Temperature Control Co., 34 E. Logan St., Philadelphia 44, Penna.*

Please mention number 1003 when filling out card



Exhaust Gas Analyzers for Engine Trouble-shooting

New "Ranarex" gas analyzers permit simple, rapid check for improper operating conditions in automobile, airplane and other

gasoline combustion engines studying exhaust gas composition and intake manifold vacuum. Analyzers not only mechanically measure gases of combustion but indicate improper manifold vacuum by a built-in vacuum gage. In application of "Ranarex" to automobile engine trouble shooting, Permutit engineers advocate a ratio of 12.5 lbs. of air for each pound of fuel when engine is idling. This ratio changes at cruising speeds, and it has been found that 15 lbs. of air per pound of fuel is optimum. Older cars perform better at 14 lbs., while trucks require a richer mixture. Whenever possible, it is best to test the engine under a load on a dynamometer or on the road. Intake mani-

fold vacuum readings are also important to correct diagnoses of incorrect air-fuel ratio since they may show wrong distributor adjustment, sticking automatic spark advance, leaks in intake system, leaky or sticky valves, incorrect valve timing, clogged exhaust systems or worn rings.—*Permutit Co., 330 West 42nd St., New York 17, N. Y.*

Please mention number 1004 when filling out card

High-frequency Probe

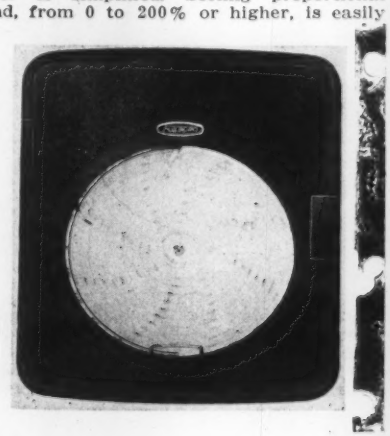
New "R-F Probe" is for functional testing of high-frequency power circuits. When probe tip is subjected to a radiofrequency field, a proportionate r-f. current is capacitively induced, rectified and indicated on Weston "506" instrument. Uses include quick detection of standing waves, shielding power leaks, r-f. choke efficiency, and circuit tracing for r-f. in all r-f. equipment and associated components without affecting operation of circuit. Shape and size of Probe permit convenient access to internal

circuits, small openings. Probe element measures ¾" diameter, 5" length; over-all length is 11". Aperture in handle permits hanging Probe near transmitter antenna leads for measuring r-f. output to aid in tuning adjustments. Probe tip is insulated sufficiently for probing into high-voltage circuits. Accidental overloads of up to 10 scale lengths will not damage instrument.—*Radio Frequency Laboratories, Inc., Boonton, N. J.*

Please mention number 1005 when filling out card

Automatic Controller for Extreme-lag Processes

New "Model 40 Controller" represents no departure in basic operating principles from those of "Model 30" (*Instruments*, July 1942, page 272) but embodies improvements in design and construction which offer new advantages said to be "important and numerous enough to characterize a wholly new instrument." Operating-panel feature of "Stabilog" control instruments is retained: when case door is open, every knob and other part normally requiring attention is accessible without removing chart. Changing from one mode of control to another is simplified. Setting proportional band, from 0 to 200% or higher, is easily



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XACTLINE'S extreme sensitivity anticipates the most minute heat variation on both cooling and heating cycles, causing an instantaneous power on-off response. Power on-off cycles as short as 3 seconds have been attained. That's why XACTLINE gives you the finest, most accurate, trouble-free and inexpensive temperature control regulator available.

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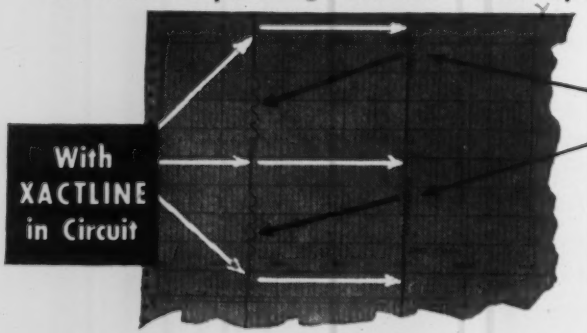

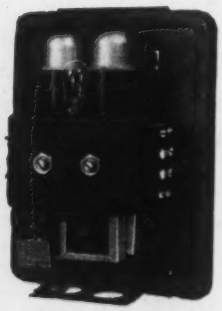

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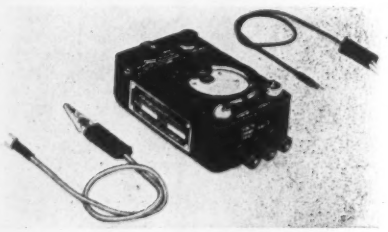
made by a thumb-wheel. Reversal of instrument action is made in a like manner. Range of reset is 500 : 1 and is a continuous adjustment. Elimination of reset and derivative functions is extremely simple when desired. A much-improved adjusting device permits zeroing pen without realigning control point. New type of transfer switch enables operator to change from manual to automatic control, or vice versa, with no valve motion. Unique mounting of transfer switch and reducing valve on a "manual control panel" permits removal of entire instrument from its location, leaving behind this sub-panel, with the process still under pneumatic control by manual operation. "Model 40" is available as an indicator as well as a single-pen and multi-pen recorder, for on-off mode, proportional, proportional and reset ("Stabilog"), proportional with derivative, and proportional and reset with derivative ("Hyper-Reset").—*The Foxboro Company, Foxboro, Mass.*

Please mention number 1006 when filling out card

Pocket-size Electrical Tester

New pocket size electrical tester provides a d-c. voltmeter with 0 to 30 volts; a d-c. ammeter with 0 to 30 amperes; an ohmmeter

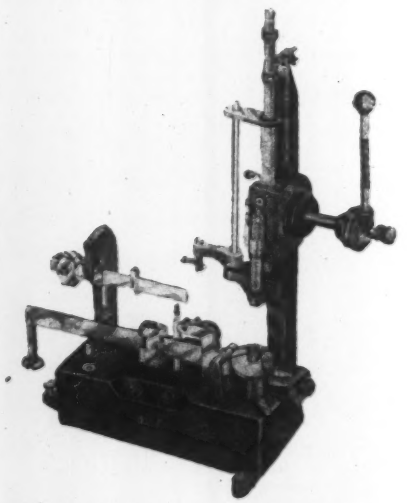


with 100 ohms full-scale and 5 ohms center-scale; a continuity test light, 3-volt internal battery; and a 28-volt light for hunting "hot" circuits.—*Dept. BN, Airquipment Co., 2820 Ontario St., Burbank, Calif.*

Please mention number 1007 when filling out card

Spring Tester

New "B-L-P Spring Tester" is for testing compression and expansion springs at specified values; is a production-line spring testing machine as well as a laboratory precision spring testing device. It is micrometer set to desired measurement with settings to 0.001". Then, minimum tolerance value of desired spring tension is set on primary scale. Third, maximum tolerance value of desired spring tension is set on secondary scale. Any number of identically



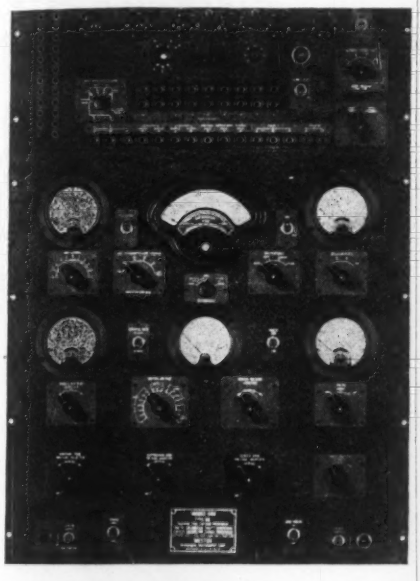
manufactured springs ranging in tension values from 0 to 20 lbs. can be measured accurately without further adjustment. Signal lights indicate when spring meets minimum tolerance requirements and again

when it exceeds maximum tolerance requirements. Scale calibrations are measured in increments of 0.01 lb. Instrument allows any operator to obtain accurate readings in a few seconds. Less than 250 milligrams will activate the measuring beam. Larger models can be furnished on order to required specifications.—*Skyway Precision Tool Co., 3217 Casitas Ave., Los Angeles, Calif.*

Please mention number 1008 when filling out card

Mutual Conductance Vacuum Tube Analyzer

New "Model 686" vacuum-tube analyzer tests tubes precisely as they are used and is a true mutual conductance analyzer. It contains a well-filtered a-c. and d-c. potential supply, indicators for standardizing

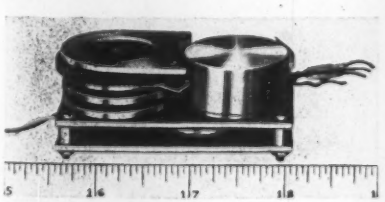


each element voltage and current, a grid current microammeter, and a large fan-shaped instrument calibrated in mutual conductance with ranges of 4,000, 6,000 and 15,000 micromhos. Upper portion contains a separate socket panel with each tube element terminated at a separate pin jack. All power supply and measuring circuits terminate in a second set of pin jacks. Patch cords are used to connect any tube for analysis. External circuit components may also be patched in for study purposes. All tubes are tested under manufacturer's rated operating conditions or exactly as they are used in their associated equipment. Basic design of analyzer and separated socket panel provide a unit which can be easily adapted to study of all existing receiving tubes as well as future tube releases. Said to be indispensable for laboratory and production analysis, new analyzer is also of value to technical schools and colleges for student tube analysis. — *Weston Electrical Instrument Corp., 617 Frelinghuysen Ave., Newark 5, N. J.*

Please mention number 1009 when filling out card

Micro X-ray Diffraction Camera

New "Norelco Micro X-ray Diffraction Camera" permits study of minute sections and charting changes over microscopic areas; is said to embody the most advanced



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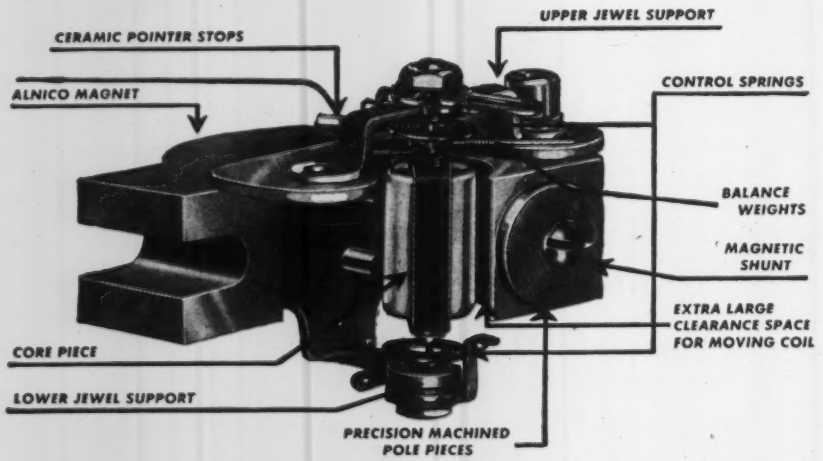

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6. BALANCE WEIGHTS of helical type phosphor bronze are used to balance the moving element, so formed as to eliminate slipping or shifting.
7. MAGNETIC SHUNT is standard equipment on each DC instrument, insuring uniform damping characteristics.

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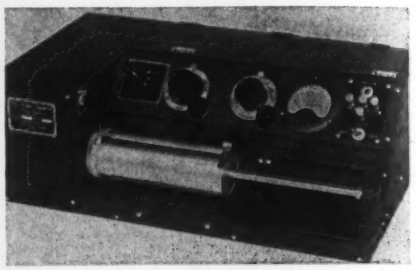
ideas and to combine a number of unique features. Designed to fit "Norelco" x-ray diffraction unit, new camera comprises a precision-machined body which is readily removable from its carriage for loading. Special features permit instantaneous removal and replacement without loss of alignment. Two specimen holders are provided: one comprises a special positioning and tensioning device for fibres, narrow strips or similar objects; the other utilizes a flat plate insert to accommodate microtomed sections, etc. A special film cassette with beam stop is provided and a hose connection on the body permits gas filling or pressure reduction. Accessories include an additional smaller pinhole system, ring adapter to be used on microscope when adjusting specimen in camera, extra spacing insert for film cassette, adjusting wrenches and film punch. Camera and parts are packed in a special instrument box accompanied by operating instructions. — *North American Philips Company, Inc., 100 East 42nd St., New York 17, N. Y.*

Please mention number 1010 when filling out card

High-speed Recorders

New "Recorders Model RF and Model TXC," while primarily designed for recording facsimile transmissions on photo-sensitive or electro-sensitive paper, have been

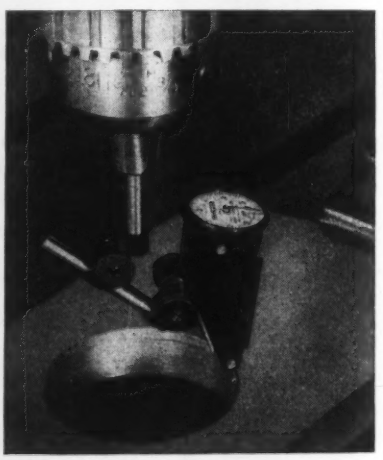


found useful in applications where accurate recording of millisecond intervals over a long period is required. Indication is instantaneous. "Model RF" will record time intervals up to seven minutes with an accuracy of one millisecond on a sheet 7" × 9". "Model TXC" has a recording capacity of 20 minutes on a sheet 12" × 18". Recorders can be modified to provide increased capacity; may also be used to measure audio frequencies or frequency drift with a precision of one part in one million.—*Times Telephoto Equipment, Inc., 229 W. 43rd St., New York 18, N. Y.*

Please mention number 1011 when filling out card

Perpendicular Type Dial Indicator

New type of "Testmaster Universal Indicator" is constructed with dial perpendicular to axis of body of instrument, making

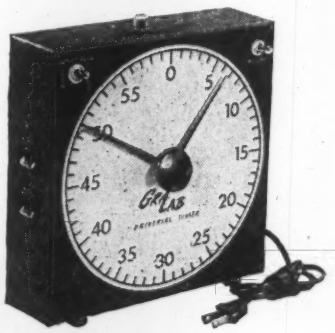


it useful for general machine shop, tool room and inspection jobs where perpendicular position of dial improves readability, resulting in greater accuracy. Dovetails, friction clamps and rods provide for setting of indicator to check a wide range of hole sizes, with dial in a horizontal position. "Models 5 and 6" (English) are graduated 0.001" and 0.0001" respectively. "Models 7 and 8" (Metric) in 0.0025mm. and 0.01mm. respectively. Instrument comes in a plastic case, complete with dovetail clamp and toolpost holding bar.—*Federal Products Corp., 1144 Eddy St., Providence 1, R. I.*

Please mention number 1012 when filling out card

Electric Timer

New "Gralab Universal Timer" is designed for precise timing of operations (in seconds) up to one hour. It is equipped with

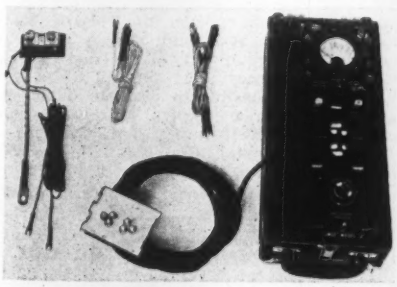


two outlets for making or breaking of two circuits. It is operated by a synchronous clock motor and can convey a load up to 750 watts. (Load capacity may be increased by use of a relay.) Orders can specify 25-, 40-, 50- or 60-cycle motors. Timer has an 8" aluminum dial. Second and minute hands can be set in total darkness. Baked on enamel case is 8½" square, 2⅝" deep, can be placed on table or shelf or hung on the wall. An audible alarm, which sounds at end of set time, is a convenience for work in total darkness.—*Gray Laboratory & Mfg. Co., 43 W. Apple St., Dayton 2, Ohio.*

Please mention number 1013 when filling out card

Portable Aircraft Analyzer

New portable electrical aircraft analyzer will simultaneously check generator voltage, field current, regulator, generator relay, in-



struments and wiring of any single- or multi-engine plane. It can be used as a d-c. voltmeter with 30-, 300-, and 1500-volt ranges as well as a 30- and 300-ampere ammeter.—*Dept. BN, Airquipment Co., 2820 Ontario St., Burbank, Calif.*

Please mention number 1014 when filling out card

Pressure Gages in Larger Dial Sizes

New "Supergauge" is announced as answer to a "long-standing demand for a large dial size pressure gage at a nominal price." It is a heavy-duty type pressure gage suitable for the most severe industrial service. Internal parts are made of high-

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This general purpose potentiometer, incorporating a number of notable refinements in potentiometer design, is widely used for precise temperature measurements including thermocouple standardization, for meter calibration, for checking portable potentiometers and for other critical measurements of DC potentials requiring exceptionally high accuracy. Distinctive features include:

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4. Special provisions to minimize parasitic thermal emf's—including automatic compensation of slidewire thermals and gold contacts in galvanometer key.
5. Exceptional convenience in reading and adjustment.
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A two-dial instrument with built-in standard cell, galvanometer and battery, available in a variety of ranges for laboratory, plant and field applications. Described in Bulletins 270 and 270A.

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- It increases the speed of soldering operations — and provides a result often impossible with other methods.
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- It is cheaper to operate than a solder pot, consuming only 775 watts at full load and only 100 watts on standby. Power is drawn only when soldering is taking place.
- No moving parts to wear out. Tube replacement costs low. All components are designed with generous safety factor.
- The heater offers less hazard than a soldering iron, and yet does a neater, cleaner, faster job . . . without danger of sparking or radio frequency burns.

$360.00 *F.O.B. Manchester, N. H.*

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Each unit is accompanied by a manual which covers not only operating and service information, but also the design of the work coils for fundamental shapes such as square, rectangular, round and oval.

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Power Supply: 115 volts, 60 cycle ● **Size:** 15¾" x 21½" x 15" ● **Mounting:** Standard relay rack cabinet ● **Weight:** 150 pounds ● **Power Consumption:** 775 watts at full power output, 100 watts standby.

The entire unit is rigidly assembled and mounted to prevent arc-over and failure of components.

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grade non-corrosive metals; working elements are designed to withstand repeated pulsation and vibration as well as abnormally high overpressures. It is said to be styled so that it can be read "at greater distances than any other dial type gage, as the result of a comprehensive study of basic color harmony and distinctive dial markings. It is the only functionally styled instrument of its kind on the market." New gages are available in pressures ranging from 30 lbs./in.^{2} up to 10,000 lbs./in.^{2} and in 4½", 6" and 8½" dial sizes.—*United States Gauge Div., American Machine and Metals, Inc., Sellersville, Pa.*

Please mention number 1015 when filling out card.

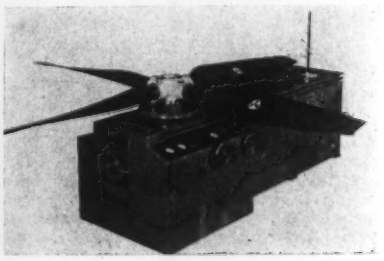
Switchboard Tachometer for Low Speeds

New "Series 40B" tachometers measure speeds as low as 1 r.p.m. or ¼ foot per minute, are available for continuous indicating or recording application, are said to be particularly useful for measuring extrusion speeds in metal processing mills. Indicator or recorder may be mounted any distance from tachometer head, which is a simple contact-making mechanism connected in series with a reactance and with indicator to a voltage source so that current flowing through indicator is directly proportional to speed. Operating power is obtained from 110-volts 60-cycle supply and calibration is unaffected by changes in line voltage. Moving parts are few and simple and are mounted in permanently-lubricated ball bearings. Accuracy is 1% of full scale. It is said to be impossible to damage device by accidental over-speeding. Multiple ranges and multiple head units are available.—*Metron Instrument Co., 422 Lincoln St., Denver 9, Colo.*

Please mention number 1016 when filling out card.

Aircraft Propeller Regulator Test Stand

New "Model T-133 Combination Propeller Hub and Regulator Test Rig" is designed for testing hydraulic functions of variable-pitch propellers. Following tests

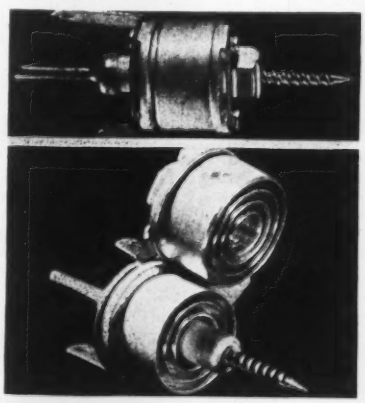


can be performed on this stand: *Regulator:* (1) Pressure control valve opening pressure; (2) Pump flow; (3) Maximum control speed of governor; (4) Governor sensitivity; (5) External and internal leaks; *Hub:* (1) External and internal oil leaks; (2) General operation; (3) Rate of pitch change (timer). Propeller hub is mounted on a surface plate so designed that blades can be rotated 360° while under pressure for checking propeller track. Construction of stand permits its use as an assembly bench. Welded steel base of test rig has two oil reservoirs welded integrally into base. Hub test head is located on front end of surface plate. Regulator drive shaft, mounted on pillow blocks on underside of surface plate at front end of rig, is driven by V belts through a fixed-stroke-piston fluid motor piped to a variable-delivery-piston pump driven by a 10 h.p. electric motor. This hydraulic drive permits infinitely variable speeds from 0 to 2000 r.p.m. Instrument panel, control valves and regulator speed control are located on right side at front of rig. Regulator is mounted inside of rig at front end. A flexible hose with a hand valve permits filling regulator by pressing "Charge Start" button on instrument panel. Function of rotary seal gland is to transfer oil pressure from rotating regulator through regulator drive shaft and rotary seal and test head to propeller hub sockets. Standard AN type "O" ring seals are used for pressure sealing. Flexible water and hydraulic lines and a floating torque arm help eliminate side thrust and wear.—*Hydraulic Machinery, Inc., 12825 Ford Road, Dearborn, Mich.*

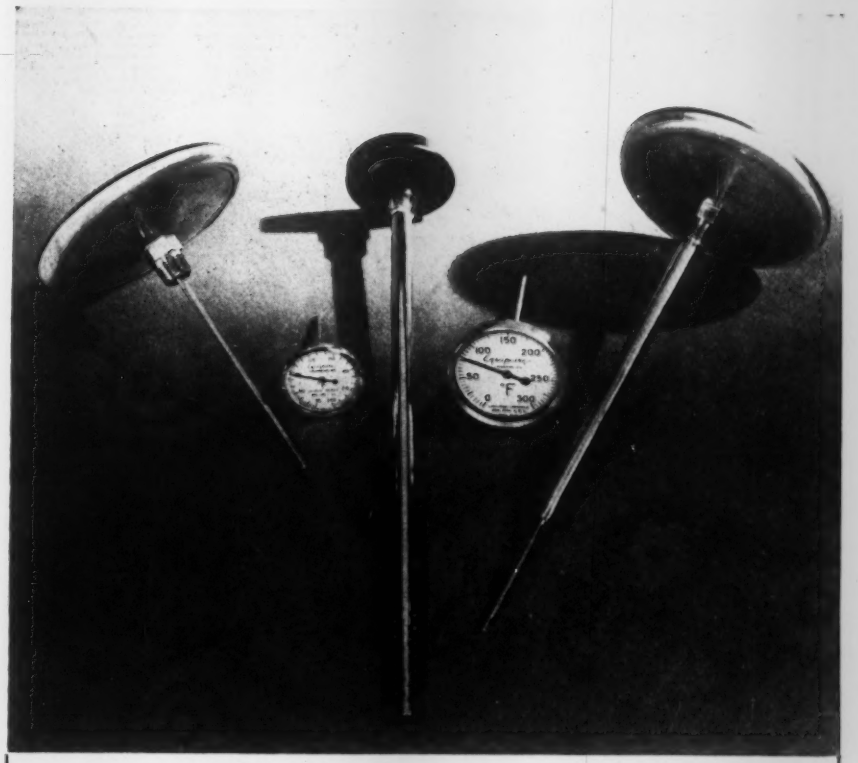
Please mention number 1017 when filling out card

Air Capacitors for Trimmer Applications

New "Hi-Q" air capacitor said to have extraordinary mechanical and electrical stability consists of two sets of concentric aluminum cylinders which are moved together or apart along a common longitudinal axis by means of a screw. Rotor and stator are one-piece assemblies and have a low value of inductance. This unique design



makes new trimmers mechanically strong and easy of adjustment. Less than ½" in diameter and 1 7/16" in length, units are useful to beyond 500 Mc. for trimming or tuning. Capacitance range is 3 to 30 mmf. and linear relationship covers 27 mmf. over three full rotations. It is said that selected



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for every industrial and laboratory use

Widely used in power plants, chemical plants, oil refineries, paper and textile mills, etc. Also on refrigeration, air conditioning and electrical equipment.

Many standard ranges are available between the limits of minus 90°F. and 1000°F.

- Easy to Read Dial
- Instantaneous Response
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settings remain permanent by virtue of a special retention spring and that vibration does not disturb capacitance because a long rotor-bearing sleeve closely hugs a matching central ceramic insulator. Unit has two solder terminals and is light enough to be mounted directly on connecting leads. It was developed in the Philips Laboratories at Eindhoven, Holland. — *North American Philips Co., Inc., 100 East 42nd Street, New York 17, N. Y.*

Please mention number 1018 when filling out card

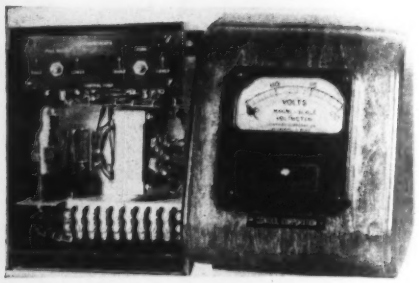
Immersion Thermocouple for Aluminum, Lead, etc.

New Thermocouple for molten aluminum is said to be suitable also for lead, babbitt, zinc, type metal and similar low-melting-temperature metals. With this new thermocouple, it is claimed that instrument readings are "unaffected by couple wire conditions and parasitic current generation is wholly absent at the hot junction—situations that occurred formerly." In operation, couple is immersed several inches below surface of bath and held there until a steady reading is obtained on measuring instrument, usually 10 to 12 seconds. Couple is then withdrawn, adhering metal being removed by shaking handle.—*Brown Instrument Co., 4482 Wayne Ave., Philadelphia 44, Penna.*

Please mention number 1019 when filling out card

Suppressed-zero Voltmeter

New "Desk Model Magni-Scale Voltmeter" was developed for accurate indication of a narrow a-c voltage range. It incorporates features previously offered in panel-mounted "Magni-Scale" voltmeters, including a simple electronic circuit that expands a narrow section of voltage range, provides trouble-free operation and high accuracy, with a linear scale. Electronic equipment uses only two tubes, neither critical in regard to calibration. Voltmeter circuit will hold its calibration over a long period of time. Instruments can be provided

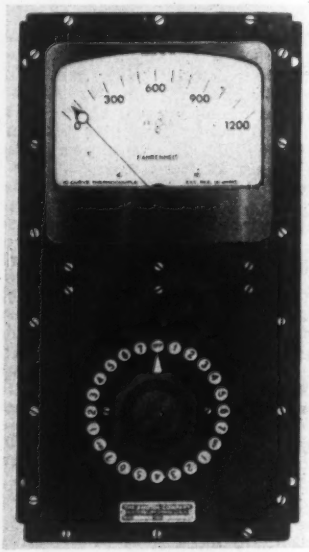


for operation directly on a-c. circuits or through instrument transformers, calibrated in the voltage range being used. Where desired, this instrument can be used in connection with telemetering equipment to provide "Magni-Scale" voltage readings at any desired distance. — *Control Corp., 718 Central Ave., Minneapolis 14, Minn.*

Please mention number 1020 when filling out card

Diesel Engine Pyrometer

New "Model 6-426 Commercial Diesel Engine Pyrometer" has a millivoltmeter type of movement correctly damped to resist vi-

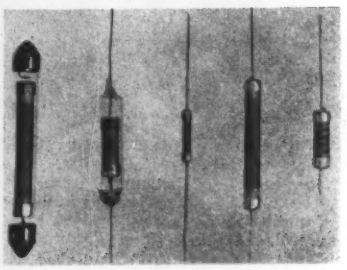


bration and yet give quick response to temperature changes. Rotary switch has 24 points and a specially designed universal dial enables user or manufacturer to adapt it for various combinations of engines and numbers of cylinders. Thermocouples for installation in practically all types of engines can be furnished.—*The Bristol Company, Waterbury 91, Conn.*

Please mention number 1021 when filling out card

Wide-range Film-type Resistor

New film-type resistor is available for instrument, radar and television use. (Heretofore it was exclusively used by the Armed Forces.) At present it will be available in two sizes: (a) 1 watt: ¼" diam. × ⅞" long, axial leads, resistance range 10 ohms to 35

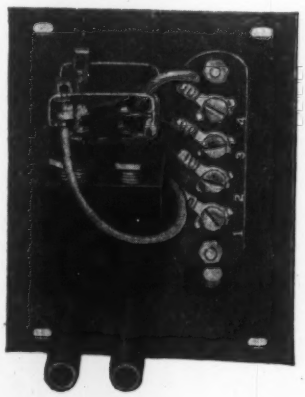


megohms, 1% accuracy. (b) 2 watts: ¼" diam. × 2" long, axial leads, resistance range 10 ohms to 100 megohms at 1% accuracy. Soon available, ½ watt: ⅛" diam. × ⅞" long, resistance range 10 ohms to 15 megohms at 1% accuracy. It will be possible later to supply these same resistors hermetically sealed in glass, attaining 0.15% accuracy. What is said to be the unique characteristic of these resistors is that they can be supplied in 1% accuracy at 100 megohms with temperature, voltage and humidity coefficients within 0.1%.—*Wilkor Products, Inc., 3835 W. 150th St., Cleveland 11, Ohio.*

Please mention number 1022 when filling out card

Ready-to-use Cells for Gas-analysis Systems

New "Thermal Conductivity Units" are for use with standard potentiometers, recorders or galvanometers, and any suitable constant-voltage d-c. supply. For most practical applications, cell units are interchangeable and zero balance of unit is stable and free of temperature and current effects. Pressure test: Novel mounting of individual



cells obviates use of cements; is impervious to gases at normal operating pressures. All units are tested to 10 lbs. of air before shipping, can be tested to higher pressures, if desired. Resistance filaments are straight wires, relatively undisturbed by vibration and heating distortion. "Diffusion Type Thermal Conductivity Cell Unit Assembly" consists of 4 filaments, assembled in a balanced bridge. Average cell unit characteristics: Operating current (air in all cells) = 0.2 amp.; voltage drop (room temperature) = 1.2 volts; bridge internal resistance = 12 ohms; gas sensitivity (no load) approx. 0.75 MV per 1% CO_2: change in CO_2-N_2 mixtures. Electrical zero balance relatively stable with variations of: Operating current ±0.01 amp., room temperature ±10°C. Approx. dimensions of Cell Unit Assembly without housing: Depth 1½"; width 3½"; height 2⅜"; approx. net weight 1½ lbs. Housing for cell unit assembly with terminal panel for power supply, and galvanometer leads measures approx. 3"×4"×5".—*Gow-Mac Instrument Co., 22 Lawrence St., Newark, N. J.*

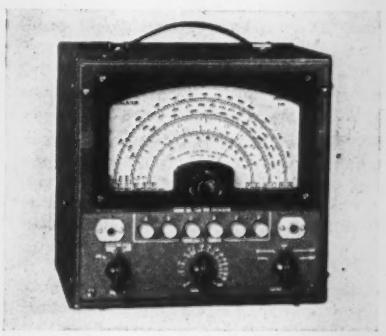
Please mention number 1023 when filling out card

Milliwatt-power Instrument Motor

New "Model GZ Drag Cup Motor" is particularly designed to maintain continual alignment, to synchronize circuits for the immediate engagement of "L-201" automatic flight control system and to hold pitch axis input signal at null at all times prior to engagement. Its mechanical power output is 7.4 milliwatts, or ninety-nine one-millionths horsepower. Circuits of the "L-201" automatic flight control system are continually aligned and synchronized by rotating a "Learsyn" which produces signal voltage developing error signal and causing amplifier channel to operate system. New

STAYS ACCURATE—Year After Year

Here's a sturdy, modern test oscillator that's accurate when you buy it—and keeps its accuracy in long service. Convenient push button selection of ranges from 100KC to 30MC.



MODEL 640
TEST OSCILLATOR

A complete standard type oscillator for all general purpose work. Full range direct reading dial. All ranges are fundamental frequencies. No skips or harmonics calibrated.

Accuracy guaranteed to ½ of 1% on all ranges.

Push button selection of all ranges makes operation fast and accurate.

Glass enclosed dial prevents dust and protects the pointer.

Two circuit attenuator provides variable ratio and also vernier control.

Powerful signal output usable as pure or modulated R. F. carrier is modulated at approximately 30%. The A. F. voltage is available for external use.

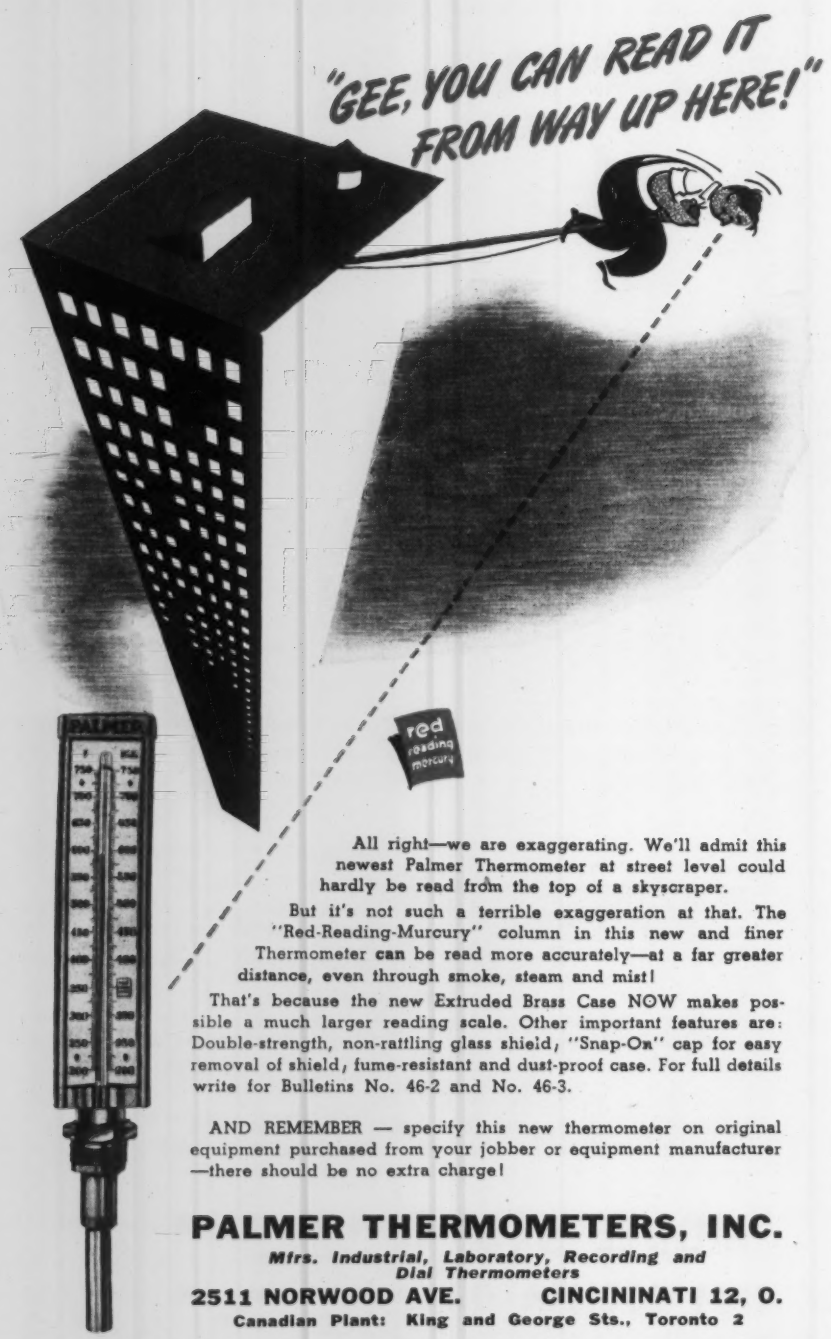
Operates from 110 volts 60 cycles. Uses three tubes: rectifier, oscillator, and modulator.

Dimensions: 8½" x 8½" x 6½".

JACKSON

Fine Electrical Testing Instruments

JACKSON ELECTRICAL INSTRUMENT COMPANY, DAYTON, OHIO



All right—we are exaggerating. We'll admit this newest Palmer Thermometer at street level could hardly be read from the top of a skyscraper.

But it's not such a terrible exaggeration at that. The "Red-Reading-Murcury" column in this new and finer Thermometer can be read more accurately—at a far greater distance, even through smoke, steam and mist!

That's because the new Extruded Brass Case NOW makes possible a much larger reading scale. Other important features are: Double-strength, non-rattling glass shield, "Snap-On" cap for easy removal of shield, fume-resistant and dust-proof case. For full details write for Bulletins No. 46-2 and No. 46-3.

AND REMEMBER — specify this new thermometer on original equipment purchased from your jobber or equipment manufacturer —there should be no extra charge!

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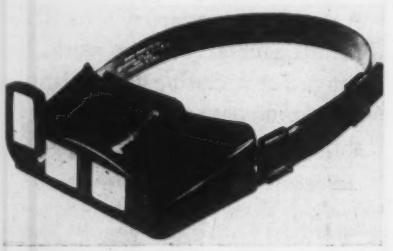
motor eliminates necessity for manual synchronization before engagement. It is a two-phase 500-cycle motor producing torque at approx. 0.002 ounce inches at 5000 rpm. and weighing less than 0.05 lb.—*Lear, Inc., 110 Ionia Ave., NW, Grand Rapids 2, Mich.*

Please mention number 1024 when filling out card

Binocular Magnifier with Auxiliary Higher-power Lens

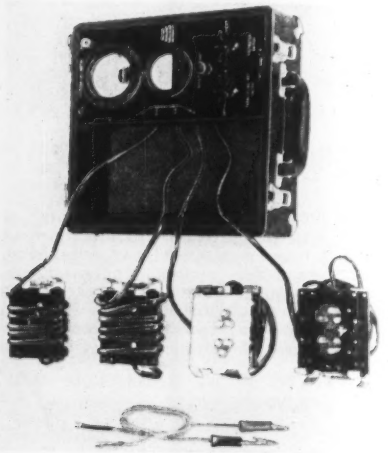


New "Double Utility Hi-Power Magni-Focuser" is later addition to maker's line of "Magni-Focuser Binocular Eye Loupes," which have been illustrated and described in this department. This new instrument incorporates optical advantages of regular "Magni-Focuser" and has a high-power auxiliary lens which drops down in front of one eye in order to provide extra magnification when needed for some particularly precise job. When not in use, "hi-power lens" flips up out of the way. Initial production of new unit will be in focal lengths from 14″ to 8″ and from 4″ to 2″ with auxiliary lens in place. These units will be designated as "Models 13, 15, and 17," according to the power of the lens. Powers with the auxiliary lens in place run from 5.25 to 6.25.—*Edroy Products Co., 480 Lexington Ave., New York 17, N. Y.*

Please mention number 1025 when filling out card

Portable Aircraft Voltage Regulator

New portable aircraft voltage regulator is designed to accurately balance generator output on all multi-engine planes. It has a

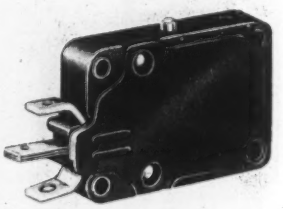


2% base accuracy; also a sensitive adjusting mechanism said to permit perfect synchronization. It eliminates danger of "boiling" new batteries. In actual flight, where sufficient loads can be applied, this lightweight instrument is suited for accurately paralleling the generators. "Voltage Only" readings can also be made.—*Dept. BN, Aviquipment Co., 2820 Ontario St., Burbank, Calif.*

Please mention number 1026 when filling out card

Miniature Switch

New "Model M Rolling Spring" snap-action electric switch has improved structural features: Its new molded case is

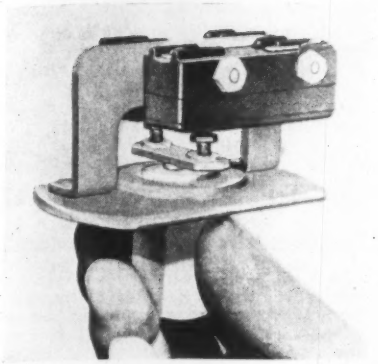


designed for greater strength by means of a fully recessed cover which is inserted clear of the four 3/32″ mounting holes. Size of barriers between terminals has been increased. To make wiring easier, heavier holder terminals are used with 0.082″ terminal holes. New switch is made for single and multiple assemblies. Four of these switches can be mounted in a space of less than 1⅛″. It is made with single-pole, single- or double-throw contacts and is rated at 10 amps. 125 volts a-c. "Model M" switch can be fitted with various types of actuators.—*Acro Electric Co., 1324 Superior Ave., Cleveland 14, Ohio.*

Please mention number 1027 when filling out card

Pressure Switches

Three new pressure switches are announced: "Model ID" for industrial devices (illustrated), "Model SD" for special devices and "Model LP" for low pressures. Feature of all three is that value of pressure differential between on and off position may be specified and is held to close tolerances. "ID" operates on pressures up to 17 lbs./in.^{2}; differentials from 1 to 10 lbs./in.^{2}; maximum current capacities 10 amps.

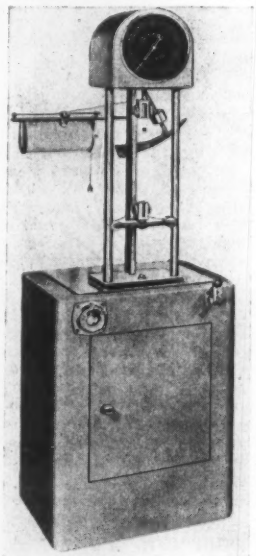


at 120 volts a.c.; weight 8 oz.; can be supplied with both circuits normally-open, both normally-closed or one of each. "SD" specifications similar except that it weighs 7 oz. "LP" is for pressures from 0 to 30" water column (gage pressure, vacuum or both); differential may be specified between 0.3 and 10.0" water; 6 to 10 amps. a.c.; weight 30 oz.; cover diam. 5".—*Cook Electric Co., 2700 Southport Ave., Chicago 14, Illinois.*

Please mention number **1028** when filling out card

Small Four-range Testing Machine

New "Low-range Tester" is expressly built for lighter materials or small finished items. It has four separate capacities, each available instantly, and shown individually



on its large dial. These ranges are: 0-10 lbs. in 1-oz. dial divisions, 0-25 lbs. in 2-oz., 0-50 lbs. in 4-oz., and 0-100 lbs. in 8-oz. Lower grip travel is continuously variable, or stepless, from 0" to 19" per minute. Accuracy is 0.5%. Other features: pendulum action, max-load reading, featherweight and swivelled upper grip, stroke limiting switches, forward-reverse switch, elongation gage, stress-strain recorder. Overall height 63", net weight 162 lbs.—*W. C. Dillon & Co., Inc., 5410 W. Harrison St., Chicago 44, Ill.*

Please mention number **1029** when filling out card

Gear Testers

Two new models of Parkson Gear Testers both have a maximum capacity of 15" center distance (a new size in addition to the 9", 24" and 36" Parkson Gear Testers on the market). One is equipped with a box-shaped upright which carries an adjustable bracket with means for clamping it in any desired position. This arrangement provides vertical centers for holding gears or pinions that are cut integral with

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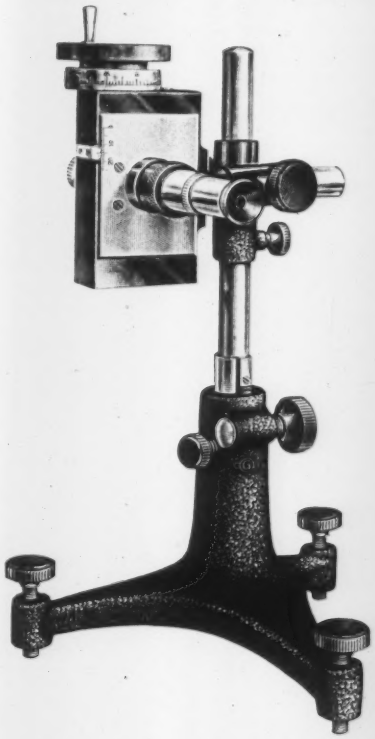

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CATHETOMETER

for accurate linear vertical measurements (inch or metric)

up to 4" (100mm) range reading up to .00005" (.001mm)

The illustration shows one of our small cathetometers built up of a standard micrometer slide, microscope and support.

Micrometer slides of various ranges and accuracies together with microscopes of different types and powers and a variety of supports can be furnished as listed in catalog M138.

These instruments are widely used in Inspection Departments and Laboratories and often may take the place of more expensive measuring equipment.

Send for Catalog M-138

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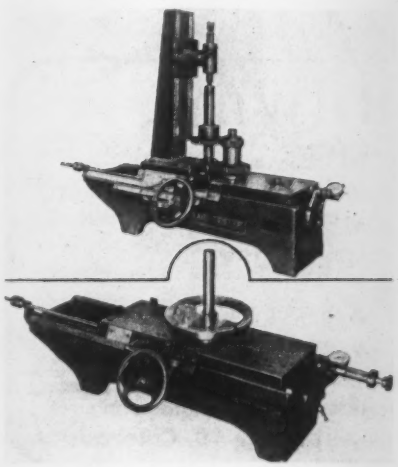
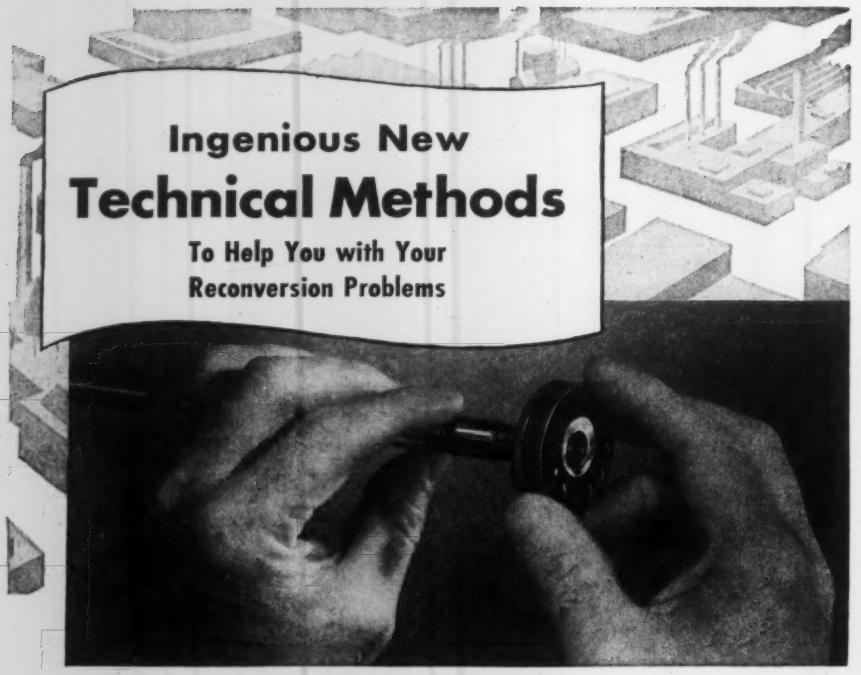


their shafts or mounted on arbors. The other has been specially designed for testing internal gears, either against the mating pinion or against a master. Both models embody a precision scale and over-size vernier for setting to correct center distance. Operation is by handwheel through rack-and-pinion, which is a new time-saving feature. Recording attachment, in addition to dial indicator, is available as optional equipment in both models.—*George Scherr Co., 200 Lafayette St., New York 12, N. Y.*

Electrical Indicating Instruments

New complete line of direct-current moving-vane type ammeters and voltmeters have long, easy-to-read scales. Pointer oscillation is minimized by a new high-torque light-weight movement. Numerals and graduations are lithographed on warp-proof color-fast metal dials, either black characters on a white background or white on

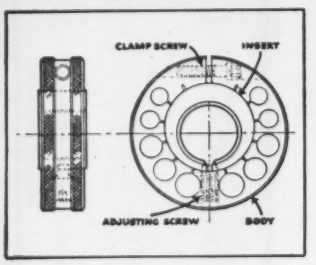


New Thread Ring Gage Starts Round Stays Round With Every Adjustment!

Employing a new principle of design, the Woodworth Thread Ring Gage closes in round within .0002 maximum after .005 adjustment. It offers greater accuracy and stability since size adjustment is controlled along thread helix angle. Threads are held securely in alignment after adjustment, due to unique adjustment means. Wear is distributed over full circumference for all resettings, thus increasing life of gage.

Positive adjustment makes it almost impossible to change setting with ordinary knocks. Positive identification by a green "go" gage and red "not go" gage saves operator time. Aluminum alloy outer body cuts weight in half, to reduce operator fatigue and increase sensitivity.

To also reduce fatigue on precision jobs, many plant owners make chewing gum available for workers. Tests show that the act of chewing aids in relieving tension, which is often the cause of fatigue. These tests further reveal that chewing Wrigley's Spearmint Gum, for instance, helps workers stay alert, thus increases their efficiency to do more accurate work.



Woodworth Thread Ring Gage

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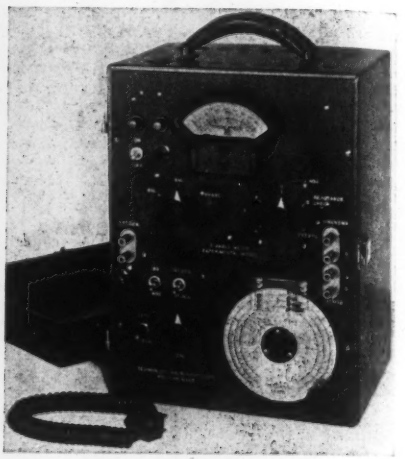
black. Center zero type scales are 80° and zero-off-center scales are 60°. New ammeters are said to be valuable for installation on equipment where severe vibration is a usual condition: automotive, marine, tractor, and diesel engine panels, also for rate-of-charge indicators on battery chargers.—*United States Gauge Division, American Machine and Metals, Inc., Sellersville, Penna.*

Please mention number 1030 when filling out card

Combination Impedance and Phase-angle Indicator

New "Type 310-A Z-Angle Meter," as its name implies, measures impedance in ohms and phase angle in degrees. It is direct-reading in these magnitudes over entire audio-frequency spectrum. Instrument is

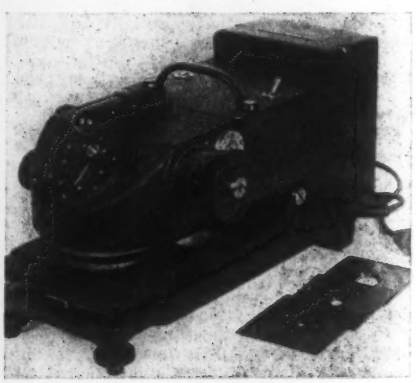


said to represent a new approach to the problem of impedance measurement: circuit used is basically different from that of conventional a-c. bridges in that measurement of impedance and phase angle is not dependent upon frequency. Instrument thus opens up new possibilities for engineers who wish to measure, over a wide range of frequencies, such things as transformers, lines, microphones, loudspeakers, filters, networks and coils. In addition it is said to do the work of a universal bridge, in that it provides accurate measurements over extremely wide ranges of resistance, capacitance and inductance. Impedance range, 0.5-100,000 ohms; accuracy 1% over main decade. Phase-angle range, 0-90°; accuracy 2° of indication. Net weight, 23 lbs. Panel dimensions 10" × 14"; case depth, 10⅞".—*Technology Instrument Corp., 1058 Main St., Waltham 54, Mass.*

Please mention number 1031 when filling out card

Paper and Fabric Air Permeability Tester

New Gurley Permeometer is for measurement of air permeability of textile fabrics, porous paper, and other porous sheet materials. It differs from other apparatus in that

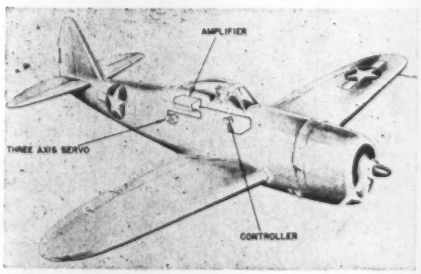


it operates as a pneumatic bridge, with results not noticeably affected by motor speed variations or other variables; but it conforms to A.S.T.M. Method D737 (Tentative Method of Test for Air Permeability of Textile Fabrics). Among numerous uses: (1) Measure suitability of cloth or paper used for vacuum cleaner bags, parachutes, dust filters, etc.; (2) Measure relative amount of wear after abrasion tests: does not destroy sample, allows same sample to be tested progressively; (3) Predict penetration of various coatings into untreated cloth; (4) Measure retention of sizing, starch, etc., after cloth has been laundered or cleaned; (5) Evaluate any process or treatment (such as napping), which affects passage of air through material. Principle of operation is analogous to use of Wheatstone bridge for measuring electrical resistance. A suction fan exhausts air from a reservoir. Voltage, speed and air flow variations have little effect on suction which is maintained by a gravity-actuated relief valve at 10" of water. Air is drawn from atmosphere through two parallel chambers into reservoir. In reference chamber, a suction of 0.5" of water is maintained; in test chamber, suction is determined by sample under test, held in clamping rings, and by a calibrated flow-meter valve. This valve, operated by a micrometer head, is adjusted until suction in the test chamber balances suction in reference chamber, as indicated by zero reading of variometer connecting the two chambers. Valve reading is then a measure of air permeability of sample. Any remaining slight variations of the low-pressure source are reflected equally and simultaneously in the two chambers. A guard ring (a groove in upper clamping ring), is connected through a needle valve to the reservoir, and, through a 3-way valve, to the variometer and reference chamber. Adjustment of needle valve balances suction in guard ring. This eliminates from the measurement any air drawn across clamped surface of a rough sample, and makes unnecessary excessive clamping pressure. Micrometer valve reading can be converted into air permeability by reference to a calibration curve or table. Gurley Permeometer will measure air permeability of materials which pass from 1 to 400 cfm. per square foot, at a pressure drop of 0.5" of water. Tests can be made rapidly: routine tests in not more than 15 seconds. Instrument weighs 15 lbs., takes samples up to 5/16" thick, and not less than 3" in diameter. Large samples may be tested without cutting.—*W. & L. E. Gurley, Troy, N. Y.*

Please mention number 1032 when filling out card

Automatic Flight Control System

New "C-2 Fatigue Relief Pilot" is an easy-to-operate automatic flight control system, weighing only 27 lbs., designed by maker in coöperation with Control Equip-



ment Branch, AAF Equipment Laboratory, Engineering Division, Air Materiel Command. Originally developed for fighter aircraft, system is equally capable of operating heavier aircraft, is said to be the lightest and most compact "package" of its kind. Being all-electric, it is easily interconnected with other control devices such as used for altitude control, instrument landing and radio homing. New system operates from a 24-28-volt system with an "extremely low" battery drain, comprises three units designed for simplicity of installation

REGULATED POWER SUPPLY

250-450 VOLTS

Wide fields of application have been opened up both in research and industry for this unit. A-C ripple is negligible and extreme care has been taken to eliminate high-frequency noise. Regulated power supply units are invaluable for such applications as amplifiers, television pulse generators, constant frequency oscillators, and measuring equipment.

Other G-E regulated power-supplies are available in the following ranges: **180-300 volts 160-1500 volts Dual Regulated**

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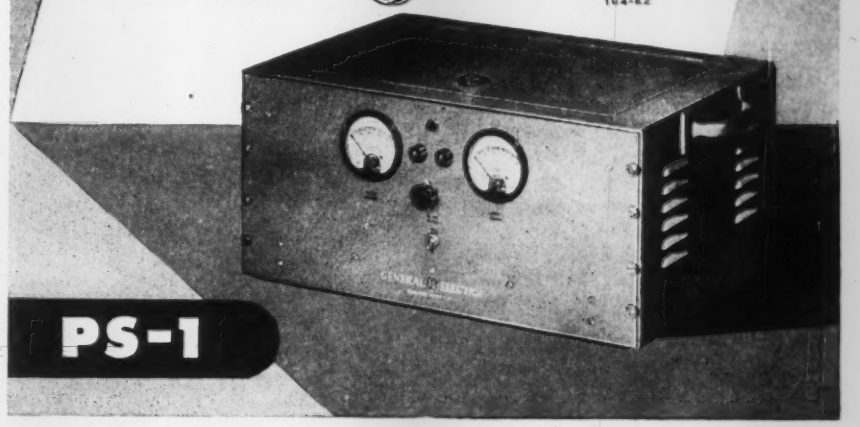
Electronic Measuring Instruments

GENERAL ELECTRIC

164-82



PS-1

BIDDLE *SPEED MEASURING INSTRUMENTS*

The "Jagabi" Hand Tachoscope is a combined stop-watch and revolution counter for precise speed measurements. Write for Bulletin 1790-I.

Whatever your speed-measuring problems, it will be to your advantage to consult with us. We offer a variety of centrifugal, chronometric and vibrating-reed instruments. Illustrated bulletins fully descriptive of all types will be sent at your request.

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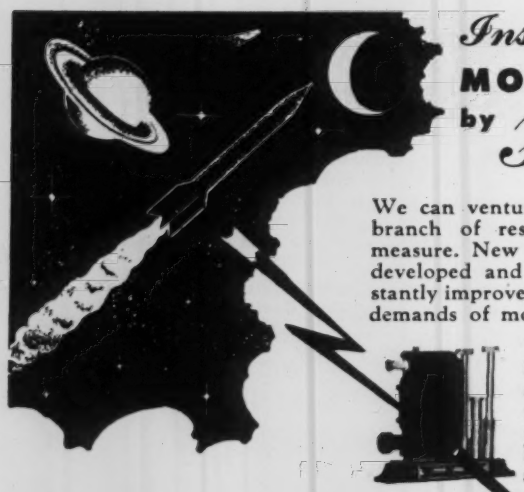

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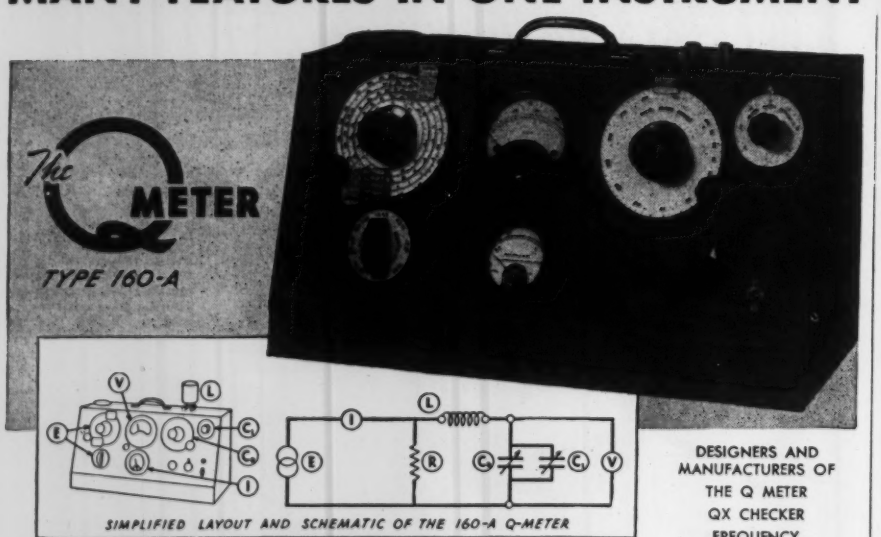

SIMPLIFIED LAYOUT AND SCHEMATIC OF THE 160-A Q-METER

THE BASIC METHOD OF MEASUREMENT EMPLOYED IN THE 160-A Q-METER
An R.F. oscillator (E) supplies a heavy current (I) to a low resistance load (R), which is accurately known. The calibrated voltage across the load resistance (R) is coupled to a series circuit consisting of the inductance under test (L) and a calibrated variable air capacitor (C_0) having a vernier section (C_1). When this series circuit is tuned to resonance by means of capacitor (C_0+C_1), the "Q" of (L) is indicated directly by the V.T. Voltmeter (V). Variations of this method are used to measure inductance, capacitance and resistance. *Oscillator Frequency Range:* 50 kc. to 75 mc. in 8 ranges. *Oscillator Frequency Accuracy:* ±1%, 50 kc.—50 mc. *Q-Measurement Range:* Directly calibrated in Q, 20-250. Multiplier extends Q range to 625. *Capacitance Range:* Main section (C_0) 30-450 mmf. Vernier section (C_1)+3 mmf, zero, —3 mmf.

DESIGNERS AND MANUFACTURERS OF
THE Q METER
QX CHECKER
FREQUENCY MODULATED SIGNAL GENERATOR
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AND OTHER DIRECT READING TEST INSTRUMENTS

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and easy maintenance: "Controller," located on or near the instrument panel; "Control Unit" or "Amplifier," which contains both the vertical and directional gyroscopes; and a triple-output friction-drive "Servo-Unit" directly operating the cables to ailerons, rudder, and elevators. No "plumbing," bleeding of lines, nor adjustment of follow-up mechanism is required; the three units are simply bolted in place and plugged into electric power source of airplane. Human pilot can engage or disengage the system, adjust amount of control force, retrim the controls in flight, and climb, turn or glide, at will. Human pilot may at any time overpower the automatic control, if necessary. Automatic synchronization simplifies engaging "Fatigue Relief Pilot" since no prior manual adjustment is required. When system is energized, airplane continues to maintain its flight attitude: any deviation of airplane from an established flight attitude is instantly measured and immediate corrective action is automatically taken. When system is disengaged by the human pilot, no violent maneuvers, "hunting" or "wallowing" occur.—*Lear, Inc., 110 Ionia Ave., N.W., Grand Rapids 2, Mich.*

Please mention number 1033 when filling out card

Radioactivity Indicators

Three new radioactivity indicators are announced:

(1) "Autoscaler," Fig. 1, for making quantitative measurements of radioactivity, is a line-operated instrument which supplies high potential for a Geiger-Mueller tube,

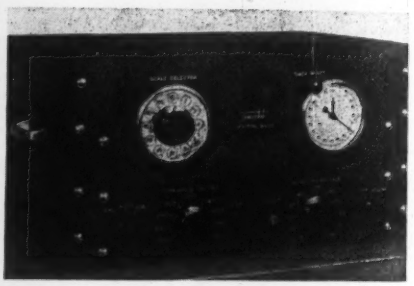


Fig. 1

counts the impulses from this tube, and measures the time required for reception of a given number of impulses. Among its special features: Automatic operation with no internal adjustments. Automatically stops and, after a predetermined number of counts up to 4096, provides a relay control contact. Can be used with all standard Geiger-

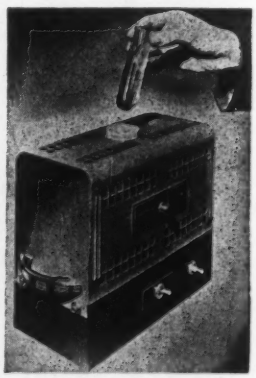


Fig. 2

Mueller tubes. Fixed statistical error for each setting of the scale selector switch. Twelve "scale by two" counter circuits can be selected to provide a predetermined number of impulses from 2^2 to 2^{12}, i.e., 4 to 4096. Statistical error: predetermined counts of 128, 256, 512, 1024, 2048, or 4096 correspond to fixed probable errors of approx. 6, 4, 3, 2, 1.5, and 1%.

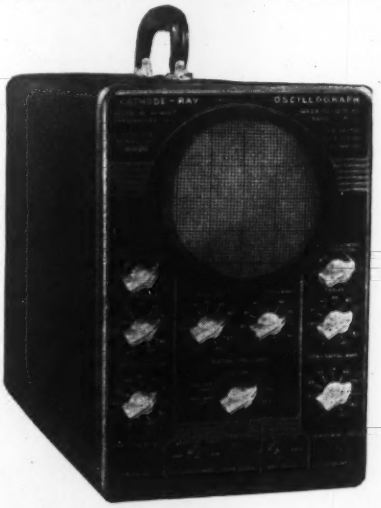
(2) "Blinker," Fig. 2, indicates by visual signal the pressure of radioactivity for simple qualitative work such as identifying commercial products.

(3) "Squawker," not illustrated, is similar to "Blinker" but produces an audible signal. —*Tracerlab Inc., 55 Olivet St., Boston, Mass.*

Please mention number 1034 when filling out card

Five-inch-screen Oscilloscope

New "Type 274" cathode-ray oscilloscope is said to answer long-standing need for a good oscillograph for routine laboratory and production testing and radio servicing, at a

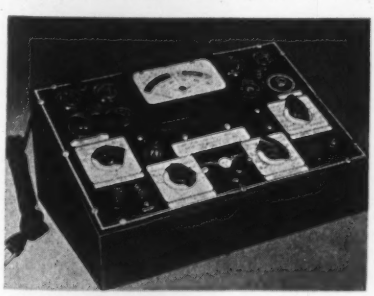


cost under a hundred dollars. It is equipped with maker's "Type 5BP1-A" 5" tube, is housed in steel cabinet with plastic carrying handle. Dimensions: 14" h., 8⅝" w., 19⅜" d. Weight, 35 lbs. Linear time-base range: 8 to 30,000 c.p.s. Synchronization may be from the vertical amplifier or an external signal. Identical vertical and horizontal amplifiers have a range from 20 to 50,000 c.p.s. There is provision for intensity modulation. Input impedance: vertical-direct 5 meg. 50 micro-microfarads; vertical amplifier 1 meg. 40 micro-microfarads. Horizontal-direct 5 meg. 60 micro-microfarads; horizontal amplifier 5 meg. 40 micro-microfarads. Frequency range: Sine wave response (at full gain) uniform within ±20% from 20 to 50,000 c.p.s., down less than 50% at 100,000 c.p.s. Deflection sensitivity: Amplifiers at full gain .65 r.m.s. volt/in; direct, plus or minus 18 r.m.s. volt/in.—*Allen B. Du Mont Laboratories, Inc., 2 Main Ave., Passaic, N. J.*

Please mention number 1035 when filling out card

Electron Tube Tester

New "Model 332 Dynoptimum" tube tester is described as a versatile instrument for quick and accurate testing of practically every known type of receiving tube. Minimum number of controls (four) saves time, also reduces costly obsolescence. Special adaptations are incorporated for checking individual sections of multi-purpose tubes. A jack is provided for headphone tests. "Model 322" comes in two types: "Model 322" is open-faced, housed in steel sloping cabinet, dimensions 12" × 6" × 8", weight



New VACUUM-TUBE VOLTMETER

measures

both voltage and decibels

—with push-button selection

This new G-E instrument is a highly sensitive electronic voltmeter that can do a combination measuring job for you: Readings from 0.001 to 300 volts can be made in ten ranges at all frequencies from 10 cycles to one megacycle; the decibel range is from minus 65 to plus 45 from a reference level of 6 milliwatts in 500 ohms. A ten-position push-button switch allows any working range to be selected instantly without passing through intermediate ranges.

DIRECT READING—STABLE OPERATION—PORTABLE

Measured values are read directly from a G-E microammeter having a dual-voltage scale graduated zero to three and zero to ten, and a decibel scale graduated minus five to plus 15. The two-stage amplifier is stabilized by negative feedback, and the effect of normal-line-voltage variations is minimized by a voltage-regulator circuit that stabilizes the voltage output of the built-in power supply. Convenient portability of this 13-pound instrument is assured by the balanced location of the snap-up leather handle and the six-foot cord furnished for operation from a 110-volt supply circuit. Write for leaflet GEA-4574. *Apparatus Dept., General Electric Co., Schenectady 5, N. Y.*

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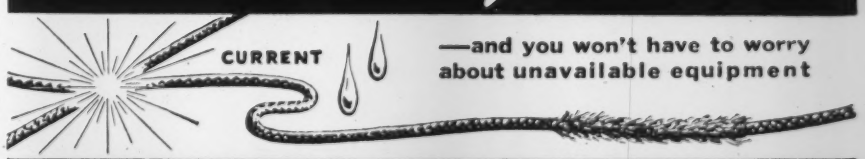

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Coverage for every requirement of testing for insulation breakdown is now provided by Associated Research's Hypot line. In addition to Models 406—410, 0-3000 volt, Hypot now includes models from 6,000 to 30,000 volts. Instantaneous reading on open scale.

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A Hypot bench model testing up to 5,000 volts. Write for detailed literature.

There's a need for a Hypot in every plant or institution where electric circuits must be safeguarded. Accurate dependable location of faulty insulation *before* burnouts may result in disaster. Ask for bulletins.

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Now available to 35,000 VOLTS
Measure true R.M.S. values on A.C., no waveform or frequency errors.

NO POWER CONSUMPTION
Leakage resistance greater than one million megohms. These meters may be used to measure.

STATIC ELECTRICITY !
Ideal for measuring high voltage power supplies with zero current drain. Rugged, well-damped movement. All elements surrounded by metal shielding for accuracy and safety.

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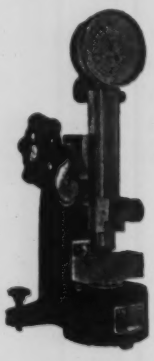

In general use for specification purposes. Simple, sturdy. Comparatively inexpensive.

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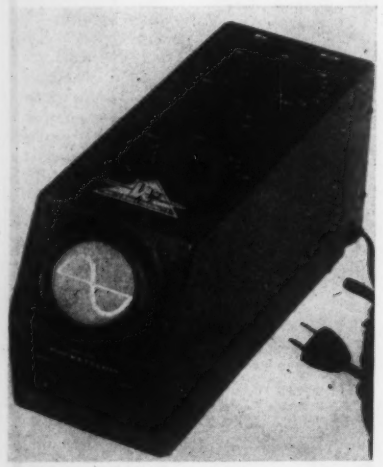
The Shore Instrument & Mfg. Co., Inc.
9025 Van Wyck Ave., Jamaica, N. Y.

8½ lbs. "Model 322-P" is supplied in a welded metal portable carrying case, dimensions 13″ × 7″ × 9″, weight 9½ lbs.—*Radio City Products Co., Inc., 127 West 26th St., New York 1, N. Y.*

Please mention number 1036 when filling out card

Portable (5½-lb.) Oscilloscope

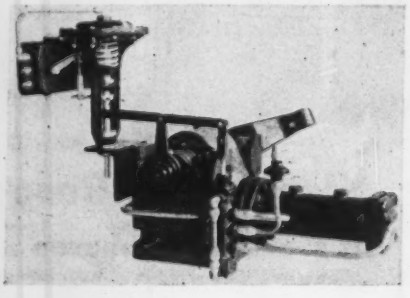
New "Model S-10-A" oscilloscope, also known as "Pocketscope," embodies all functions of conventional instrument but is easily carried by hand. It weighs 5½ lbs., measures 6⅝″ × 3¾″ × 10″ and occupies less than 0.15 ft.³ of space. Main components are cathode-ray tube, vertical and horizontal amplifiers, linear time base oscillator, synchronization means and self-contained power supply. As used normally, the vertical dimension is amplitude, and horizontal may be either amplitude or time. However, by means of external signals, any variable can be assigned to independent dimensions. Recommended uses include study of wave shapes, measurements of modulation, frequency, phase shift, voltages, power, distortion, adjustment of receivers and transmitters, tracing vacuum-tube characteristics, hysteresis and other curves. "Pocketscope" cathode-ray tube is magnetically shielded and telescoping light shield (1¼″) permits observation in places of high light intensity. Construction permits physical use on floor, on bench, or in any position convenient to operator without diminishing wide angle of vision. Controls and terminals are placed functionally to permit adjustments without reference to complicated instructions. No re-connections are required for signals passing either through amplifiers or directly to deflecting plates. Time base oscillator uses a double triode connected as a multi-vibrator, producing a substantial linear trace from 10 cps. to 50kc.—*Waterman Products Co., 2445 Emerald St., Philadelphia 25, Penna.*



Please mention number 1037 when filling out card

Pneumatic-hydraulic Power Unit for Large Valves, etc.

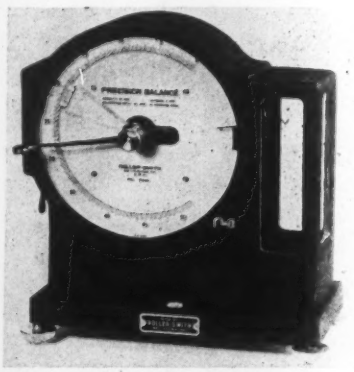
New oil-operated hydraulic booster cylinder for air operated controllers embodies a standard diaphragm top, provides high power amplification and permits exact positioning of heavy dampers, valves, etc., in accordance with the applied pneumatic loading pressure—usually 0-15 lbs./in.². Cylinder may be of crank type, as shown, or of straight reciprocating type. Straight cylinders are available up to 8″ bore and 30″ stroke. Other types of remote positioning cylinders are available using electric instead of pneumatic transmission.—*Askania Regulator Co., 1603 South Michigan Ave., Chicago, Illinois.*



Please mention number 1038 when filling out card

Rapid Precision Balance

New improved 0-500 mg. precision balance with large direct-reading dial for rapid repeat weighing is suitable for production, production control, assaying and analytical work, in lamp and radio tube manufacture, watchmaking, paint, chemical, mining, textile, etc. Choice of pans for weighing powders, liquids, ores, etc., is offered.—*Roller-Smith Co., Bethlehem, Pa.*



Please mention number 1039 when filling out card

Recording Dilatometer

New automatic dilatometer for continuous recording of thermal expansion and contraction of metals, glass, ceramics, plastics, etc., is designed to provide continuous graphs of twelve-hour expansion and contraction cycles of samples. Measurements begun during afternoon of one day may be automatically completed overnight. Except for set-up time, laboratory assistant is free for other work during twelve-hour recording cycle. In addition, Instrument is particularly useful in connection with study of ferrous alloys at thermal critical points. New dilatometer includes a furnace or sub-zero cooling chamber; furnace thermocouple; con-

centric quartz tube; specimen thermocouple; gearbox and support; transmission; contact mechanism; electronic relay; and recorder. Each of these principal units performs a separate function but all functions are closely coördinated to hold specimen temperature uniform within 1°C.; provide uniform heating and cooling with the specimen in an inert atmosphere; automatic shut-off; and an overall accuracy of 0.2%. Accommodating 3", 4" or 5" specimens, dilatometer will provide temperatures up to 1000°C.; weighs 450 lbs.; measures 56" wide, 50" high and 26" deep. It is designed for use at 110-120 volts, 50-60 cycle supply and is rated at 900-1000 watts.—*Electronics Div., Sylvania Electric Products, Inc., 500 Fifth Ave., New York City.*

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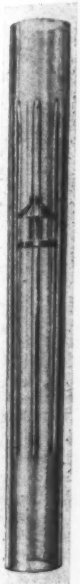


Rotameter Tubes with Integral Float Guides

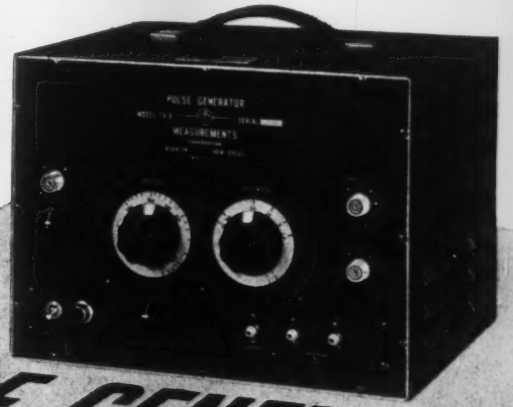
New "Bead-Guide" Rotameter metering tube has three longitudinal ribs on its inner face, which obviate necessity for float guide rods since they guide any shaped float. Float position is visible in opaque liquids since clearance between "Bead-Guide" and float edge is only a few thousandths of an inch. Corrosive liquids can be handled readily since float material can be selected without considering need for drilling it and without having to consider guide wire materials. New tubes are available in sizes "4" to "12" to replace conventional tubes now in use in Rotameters.—*Fischer & Porter Co., Dept. 5C-6, Hatboro, Pa.*

Please mention number 1041 when filling out card

Electronic Micrometers for Compressible or Non-compressible Materials

Four re-designed models of maker's "Electronic Micrometers" for precise thickness measurement in shop or laboratory are announced. All utilize an electronic circuit in conjunction with a micrometer screw thread, as described in *Instruments*, Aug. 1941, page 224; Oct. 1941, page 321; Sept. 1942, page 381. Unskilled operators, it is said, are assured of consistently accurate readings to 0.00005" on production testing lines. Units are portable and weigh 20 lbs. complete. "Model L" is for pressureless measurement of conducting parts such as radio tube grids and small assemblies as well as deflections of diaphragms and springs. "Model M" is for measuring diameter and out-of-round condition of fine, soft- annealed

Laboratory Standards



PULSE GENERATOR

MODEL 79-B

SPECIFICATIONS:

FREQUENCY: continuously variable 60 to 100,000 cycles.
PULSE WIDTH: continuously variable 0.5 to 40 microseconds.
OUTPUT VOLTAGE: Approximately 150 volts positive.
OUTPUT IMPEDANCE: 6Y6G cathode follower with 1000 ohm load.
R. F. MODULATOR: Built-in carrier modulator applies pulse modulation to any r.f. carrier below 100 mc.
MISCELLANEOUS: Displaced sync output, individually calibrated frequency and pulse width dials, 117 volt, 40-60 cycles operation, size 14"x10"x10", wt. 31 lbs.

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One sure guide to efficiency is knowing just how your machines are performing. There'll be no guesswork when you're using Corbin Industrial Tachometers!

Ruggedly built, Corbin Tachometers embody a cross-balanced, centrifugal governor . . . are sensitive without oscillation . . . positive and long lasting. They require no lubrication, and are unaffected by temperature or vibration . . . can be calibrated to RPM, tons per hour, bottles per hour, minutes drying time, sheets per minute — in short, to meet practically every industrial requirement.

Call on us for prompt, complete information on Tachometers. They are available in standard hand types, or can be engineered to meet your special requirements.

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Accurate CORBIN *Tachometers*

BRADLEY

PHOTO ELECTRIC CELLS

Many Standard Mountings.

In addition to the housed model shown here, with its plug-in contacts, Bradley also offers tube socket, nut-and-bolt types and pig-tail contact mountings.

The shapes of Luxtron photocells vary from circles to squares, with every in-between shape desired. Their sizes range from very small to the largest required.

For direct conversion of light into electric energy, specify Bradley's photocells. They are rugged, lightweight and true-to-rating.

Illustrated literature, available on request, shows more models of Bradley photocells, plus a line of copper oxide and selenium rectifiers. Write for "The Bradley Line."

BRADLEY LABORATORIES, INC.

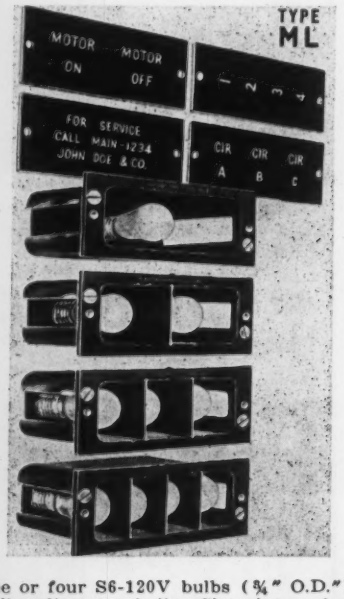
82 Meadow St. New Haven 10, Conn

wire, also paper, ribbon, strip, foil, cork, rubber, etc. "Model W" is for pressureless measurement against conducting surfaces: deflections and drift in springs, diaphragms, bimetal elements, bellows, etc. "Model 5" is for production testing of tension and compression springs, set testing of diaphragms and metal bellows, flat springs and thermostatic elements. Lower table will support a 150-pound load.—*Carson Micrometer Corp., Dept. 54, 28 Edison Place, Newark 2, N. J.*

Please mention number 1042 when filling out card

Light Signal or Annunciator System

New "ML Unit" is described as "a new and unique lighting device of an indicating nature." Bakelite basic lampholder housing can be furnished for use with one, two,

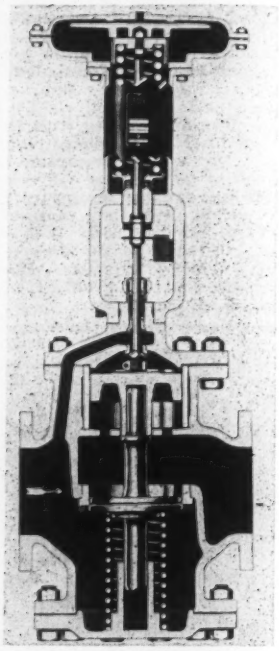


three or four S6-120V bulbs (¾" O.D.") or smaller diameter bulbs. Slots integral with case hold light-isolation barriers, readily withdrawn to permit lamp servicing. Cross ventilation is effected to each light chamber. Various face-plates are obtainable. Those illustrated resemble typical black-faced plate with white engraved markings but, in this case, inner core is translucent and, when lamp lights, message is illuminated either in white or in color, latter being created by treatment on back of plate. Over-all plate dimensions are 3¾" × 1½", with 3" × 1 1/16" alloted for actual light area. Thus, a 40-lamp annunciator for 120-volt service is 3¾" × 15". Special "ML Units" are available for use on a standard metal switchplate.—*The H. R. Kirkland Company, Morristown, N. J.*

Please mention number 1043 when filling out card

Balanced Diaphragm Valves

New single-seated fully-balanced diaphragm regulating valves (complete line for process industries and power plants) are made with cast-iron, bronze, and steel bodies for steam, air or gas pressures up to 1000 lbs./in.² and are designed to be actuated by standard pressure or temperature instruments using 20-lb. air or clean water. Valves are supplied as standard equipment with 800 Brinell hardened stainless steel main valves and Stellited seat rings, are said to provide equal or greater capacities than most double-seated regulating valves of corresponding sizes and to have additional advantage of being absolutely tight in dead end service. For temperatures over 450°F., steel diaphragm valves are equipped with newly-designed "Conden-Seal" cooling bonnet that offers a large radiating surface plus a reservoir of condensate to aid in keeping stuffing-box temperature down. New valves are normally supplied with valve below seat in closed position, opening with

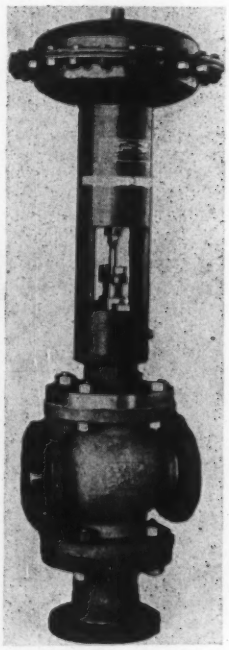


diaphragm pressure. However, by use of a new type reversing superstructure, valve can be easily changed to a normally-open-below-seat position, closing with diaphragm pressure, without changing internal parts, removing main body from pipe line, or cutting valve stems.—*Leslie Co., 225 Delafield Ave., Lyndhurst, N. J.*

Please mention number 1044 when filling out card

Diaphragm-motor Valves for Flow Diversion

New diaphragm-operated control valves for flow diversion service are of three-way type and position of diaphragm-operated valve plug determines diversion of flow between the two outlet ports from 0 to 100% flow. Valves are available in sizes ½" to 6" inclusive, in cast iron, steel, bronze, or in stainless steels available in cast form. Among features are through-bolted bonnet and blind-headed flanges, all-steel diaphragm superstructure, valve position indicator, two-ply Neoprene diaphragm, grease lubricator for stuffing box, bolted stuffing



box gland. Valves are suitable for operation with standard 2-15-lb. air output controllers or for controllers requiring special spring ranges. For high temperature service, air-fin bonnets are available. Face-to-face dimensions are in accord with ASA standards as covered by B16.10-1939.—*Hammel-Dahl Co., 243 Richmond St., Providence 3, R. I.*

Please mention number 1045 when filling out card

General-purpose Photoelectric Control

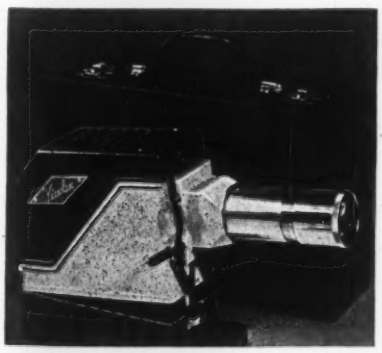
New "Series 20 and 21 Photoelectric Controls" are designed for general industrial and machinery application: counting, conveyor control, short-range signal systems,

motor or valve control, machinery safeguards, etc. Phototube is available either integral with housing or in a small separate housing. A tamper-proof sensitivity adjustment on control housing permits positive operation over varying distances between phototube and light source. Simplicity of installation is enhanced by having a single set of terminal-board connections in control to provide supply current for light source. Control is impervious to moisture, and is said to be designed to give "unlimited life under conditions of extremely high temperature and humidity."—*Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass.*

Please mention number 1046 when filling out card

Slide Projector

New "Model AP-3" 35-mm. and 2" × 2" slide projector utilizes an aspheric condenser system said to give highest lumen output per watt input. This, with 5" Luxtar



anastigmat color-corrected projection lens, is said to produce a more brilliant image than is possible with conventional optical systems. Built-in slide carrier is designed for convenience: paper, glass or metal slides are easily inserted and positioned from either direction. Heat-absorbing glass dissipates radiant heat before it reaches slide.—*Viewlex, Inc., 35-01 Queens Blvd., Long Island City 1, N. Y.*

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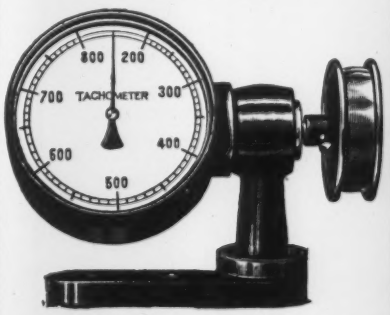

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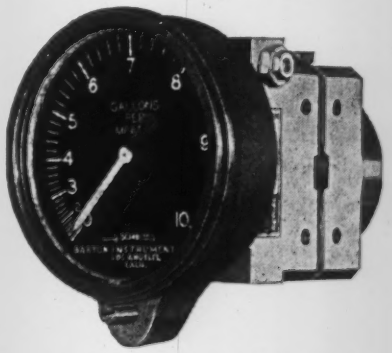

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Journal of the Instrument SOCIETY OF AMERICA

Editor, R. R. PROCTOR

Vol. 1 **No. 1**

A LETTER FROM THE EDITOR

Fellow Members of the ISA:

It is with some misgivings that we take over our new task as Editor of the ISA Section of *Instruments*. It is our hope that you will bear with us until things get rolling a little more smoothly than they are for yours truly at this moment.

This seems the logical place to explain what we can about the publications policy adopted at the Board of Directors' meeting in Pittsburgh during the recent Conference and Exhibit.

Steps have been taken to provide a monthly organ as a section of *Instruments* for our members, and arrangements have been completed with *Instruments* for ISA to edit this section. The magazine will carry an ISA mention on the cover beginning with the January issue, providing proper identification, and is to be sent to all ISA members (included in the dues) as the first item on our publications program. We have accepted the Editorship on a part time basis and will give it our best until either (a) we break down, (b) we break the job down, or (c) the ISA requires a full time Editor on the job.

"RRP"

At the request of several well-meaning advisors, we are furnishing herewith a picture which somewhat resembles "Ye Editor" in his more unharried moments. Said advisors evidently feel that you should know "what the guy looks like" when you receive requests from him for material to help fill up these columns.

Due to the rush of attending (or trying to attend) technical sessions, seeing the exhibit, attending committee meetings, and taking care of a few dozen other things during the week of the Conference, PLUS the fact that our appointment as Editor came as a complete surprise only five days before the publisher's deadline on this issue, it is impossible to fully cover the Conference activities in the ISA section of *Instruments* this time.

As a matter of fact (speaking of deadlines), part of this is being written aboard a night-flying airliner (probably flying on instruments) on our way home from the Pittsburgh Conference, only to be immediately dispatched from Chicago back to Pittsburgh via air mail in order to make the publisher's special deadline for this issue! Between fascinated observation of a beautiful display of the Aurora Borealis in the northern skies, and contemplation of the part certain instruments are and will be playing in getting this to our readers, it should be no wonder if a certain amount of incoherence shows up in this, our first literary effort since accepting the Editorship of this publication. (Being particularly instrument-conscious right now is the aftermath of a most pleasant and profitable week in Pittsburgh.)

In a more serious vein again, your Editor will shortly send a letter to each officer and section delegate to furnish material on local Section activities, as it is necessary for the Editor to have material with which to work. (And he can't pull material out of thin air.) Therefore, it is requested that each section assign to some active member the task of gathering material to forward to us each month. Such material will include advance program notices such as were formerly sent directly to *Instruments*, personals, clippings, photographs, and yes, even jokes and cartoons pertaining to Society affairs. Please send anything which you think might be of interest—the more the better.

All material should be sent to

R. R. Proctor,
2213 Ridge Avenue,
Evanston, Illinois.

The deadline for material which should appear in a certain issue is the 15th of the preceding month. All material should be in our hands by that time if we are to put it in shape and in turn meet the publisher's deadline.

GREETINGS FROM PRESIDENT FAIRCHILD

IT is a pleasure to signalize the first appearance of the ISA News Section of *Instruments* as an independently-edited organ of our Society; and to congratulate and wish success to Bob Proctor. In so doing, we must not forget to thank The Instruments Publishing Company for having so generously given pages of space and hours of editorial work from the inception of our Society — even before! This cooperation will continue, as readers will notice in coming months, when the number of pages we shall require will increase. Beginning with the January issue, this Section will be called the *ISA Journal Section* and the front cover of *Instruments* will carry an appropriate reference.

The ISA Journal Section will support the aims and ideals of *Instruments* and not compete with it. It will be a Journal for ISA affairs and activities, news and announcements, technical papers presented before the Society, special Society publications. As an example of the non-competitive spirit, I would suggest that a "Letter to the Editor" should be addressed to Editor Proctor when it is concerned with Society affairs, but if not—if it would have been addressed to our old friend Editor Behar before we had the Journal, then it should now be addressed to Behar. We hope that all our members will come to feel that this Section is our own, and will take frequent occasion to make good use of it.

C. O. FAIRCHILD

As a final thought in this general letter, please be assured that we will do our utmost to make this publication what the readers want, but to do so we must have the cooperation of all the sections. Don't wait to be asked for help — VOLUNTEER! Our slogan at the moment should be, "Every member a reporter." —RRP

JOINT MEETINGS

Elsewhere in these columns will be found a news item concerning a joint meeting of several technical societies in Charleston, W. Va. It is this sort of thing which should be sponsored and given publicity, not only in these columns, but in other magazines and newspapers. A vigorous effort to cooperate with other societies will give the ISA a boost which it can obtain in no other way.

If your section is planning to engage in joint meetings with other societies, or even with other sections of the ISA, please inform the Editor so that he can give such meetings advance publicity in this and other publications. Also, please send him a reportorial account of the meeting afterward, as this is one type of news which deserves a great play in these columns.

THANKS, PITTSBURGH–

To those of you who so thoroughly enjoyed the "Instrumentation for Tomorrow" Conference and Exhibit in Pittsburgh last month—did you ever stop to think that such things don't "just happen"? The success of the Conference was due in no small measure to the untiring efforts of many, many committees and individuals, but the lion's share of the work devolved upon one group in particular — the Pittsburgh Section of the Instrument Society of America. Hence, the biggest vote of thanks should go to this energetic group, and someone has already done something about it.

Below is the text of a letter written jointly by our Past President, Mr. Sperry (Chicago) and our newly-elected President, Mr. Fairchild (New York) to the Pittsburgh Section. We have asked for and received permission to publish this letter in these columns inasmuch as it so aptly expresses the thoughts of all of us who enjoyed the Conference.

Sept. 21st, 1946

To the Pittsburgh Section,
Instrument Society of America

Every I.S.A. man attending the Pittsburgh Conference has come away with a feeling of deepest admiration and gratitude to those who were responsible for its success. We speak for every man at the Conference when we say 'Thank you' to the Pittsburgh Section and to the men who spark-plugged the effort.

Dick Rimbach, though he was too busy working for us to partake of most of the fun himself, has achieved something that will be of lasting significance to the Society. His work has solidified and integrated the

membership around the nucleus of its National organization. The words 'Instrument Man' took on a new and fuller meaning last week.

Reg Pigott, still an "Instrument Man" at heart, came through again for I.S.A. Those who are aware of the tremendous demands that are made on his time and energy realize that I.S.A. owes him a lasting debt of gratitude.

We have long admired the scientific contributions of our Pittsburgh Chairman Paul Exline. Hats off to him for a job that includes two years of constant plugging away at his goal.

The Pittsburgh Committee—Fry, Susany, Behar, Shafer, Jacobs, Prince—all looked very happy, and for a good reason. There will be better and larger Conferences in the future, we know, but the spontaneity of this Conference could only result from the feeling of pioneering the way.

Thanks again for giving us just the needed push to put the I.S.A. over the top.

Sincerely yours,
ALBERT F. SPERRY,
Past President
C. OWEN FAIRCHILD,
President

And may we respectfully add our Editorial "Amen" to those sentiments.

CONFERENCE A SUCCESS

One can't always put in words such intangible things as feelings and "atmospheres," and it is not our intention to try to describe here the "good" feeling that characterized the Pittsburgh Conference Sept. 16th to 20th. However, something was in the air all during our stay in the William Penn Hotel. It could not be analyzed, but from our viewpoint, the simplest definition of the atmosphere would certainly include the word ENTHUSIASM.

Enthusiasm was rampant — it was noticeable in the way everybody greeted each other, in the way the exhibitors told their stories, in the reaction of the speakers, educators, audiences and visitors. If there was one remark heard above all others, it was "It's great!" Innumerable reports were heard to the effect that the Conference and Exhibit was " . . . the greatest thing which has hit the industry in years."

One had to be there to feel this elation. Mere words cannot describe it. It assures that next year's Conference will also be a SUCCESS and we urge everyone interested in any phase of instru-1947 Conference in Chicago next Sepmentation to plan NOW to attend the tember.

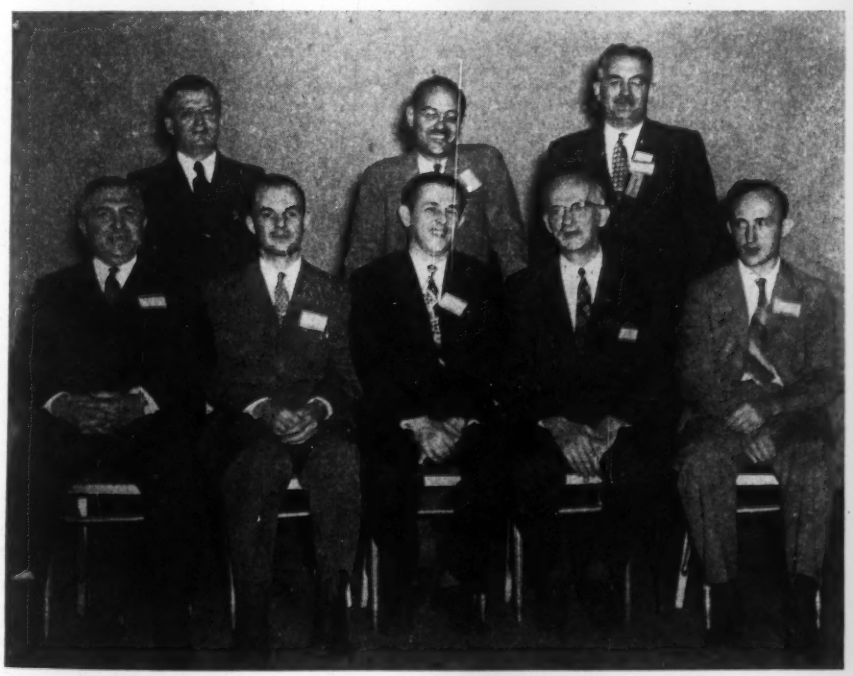
ISA "QUIZ KIDS" TAKE TO THE AIR

One unexpected bit of publicity was dropped into the surprised lap of the ISA on Friday, Sept. 20, the last day of the Pittsburgh Conference and Exhibit, in the form of a radio broadcast featuring our own Messrs. Fairchild, Sperry and Rimbach.

As a result of one of those innumerable unexpected meetings between friends and acquaintances in the William Penn Hotel, where the Conference was being held, a 15-minute program was pulled out of the hat on Thursday evening for presentation Friday morning at 9:15 over radio station KQV, Pittsburgh. Mrs. Kay Riehl, producer of a sponsored broadcast every morning over KQV, acted as master (or mistress) of ceremonies and interrogator on the ISA program, which was necessarily of an informal question-and-answer type. (Necessarily because of lack of time to think up anything more complicated.)

In answer to Mrs. Riehl's questions, the newly nicknamed "ISA Quiz Kids" explained to the listening audience some of the background of modern instrumentation, its application in the war effort and in many types of industry, and some of the reasons for and details of the Conference in session at the William Penn Hotel.

How many listeners were enlightened and how many were further confused had not been learned at this writing. That there WERE interested listeners, however, is attested by the fact that as the group emerged from the studio, a harried telephone operator facing a switchboard full of insistent red lights was doing her best to answer questions concerning the location of the exhibit, the hours, the personnel, the duration, the location of the exhibit, the (pardon us, this is where we came in).



New officers of the I.S.A. elected at the Pittsburgh meeting to serve for the 1946-47 season. Back row: Hugh E. Ferguson, Treasurer; Richard Rimbach, Executive Secretary; J. B. McMahon, Vice-president. Front row: Carl F. Kayan, First Vice-president; H. H. Barnum, Vice-president; Albert F. Sperry, Past President; C. Owen Fairchild, President; Ralph Munch, Vice-president.

THERMOCOUPLE STANDARDS SUB-COMMITTEE REPORTS PROGRESS AT 1st MEETING

The Thermocouple Standards Committee, a sub-committee of the general Recommended Practices Committee, held its first meeting in Bayway, N. J., Aug. 26 and 27, 1946, with all members present, according to the chairman, H. M. McCarthy, Standard Oil Development Co. The committee, while not ready at this time to release a complete report, has made considerable progress, and it was indicated that substantial agreement had been reached in setting up certain Tentative Recommended Practices.

The function of the Thermocouple Standards Committee is to accumulate all possible information on present thermocouple practices, including terminology, color coding of insulated thermocouple wire, insulation requirements, wire sizes, calibration curves and accuracy limits, and existing or standardized practices for temperature measurement by the thermocouple method, and to write a set of Tentative Recommended Practices which can be used as a basis for one section of a future ISA Standards publication. The first meeting resulted in the committee's unanimously approving a uniform Color Coding for Insulated Thermocouple Extension Wires, as well as some minor changes in Terminology. This material will shortly be recommended for adoption as "Tentative ISA Recommended Practices."

The next meeting of this committee has been tentatively scheduled for October, when insulation requirements and standards will be taken up. All proceedings and recommendations of the committee will be published as soon as possible.

The following are members of this committee:

H. M. McCarthy (Chairman), Standard Oil Development Co.
W. E. Boyle, Shell Oil Co., Inc.
Donald Dodkin, The Foxboro Co.
C. T. Evans, The Bristol Co.
Prof. C. F. Kayan, Columbia University
Anker F. Krogh, Brown Instrument Co.
V. L. Parsegian, Portable Products Corp.
Ward Percy, U. S. Steel Corp. Res. Lab.
John F. Quereau, Leeds & Northrup Co.
J. R. Sins, Brown Instrument Co.

CONFERENCE EXHIBITORS FORM COMMITTEE

It was felt advisable to form a committee of exhibitors' representatives to advise and assist the 1947 ISA Exhibit Committee in its preparations for next year's Exhibit. Accordingly, a meeting of the exhibitors was called at 11 A.M. on Thursday, Sept. 19, and a committee was organized under the chairmanship of W. F. Haring, Manager of Instrument Sales, Wallace & Tiernan, Newark, N. J. Representatives of the following exhibiting companies were selected to serve for one year on this committee:

American Meter Co., New York
Brush Development Co., Cleveland
Connecticut Tel. & Elec. Div. of Great American Industries, Meriden, Conn.
Equipoise Controls, New York
Fisher Governor Co., Marshalltown, Iowa
General Electric Co., Schenectady
Gotham Instruments Co., New York
Mine Safety Appliances Co., Pittsburgh
Moore Products Co., Philadelphia
Superior Electric Co., Bristol, Conn.
Waldes Kohinoor, Inc., New York
Waterman Products Co., Philadelphia

The purpose of this committee, as

stated by the organizers, is to act in an advisory capacity to the Chicago Exhibit Committee in the arrangements for the 1947 Exhibit, particularly in such matters as definition and regulation of exhibition hours, conflicts between technical sessions and exhibit hours, the selection of a slogan for the 1947 Conference, and other related matters. The committee will present a report of its next meeting (to be held shortly) and will offer its active assistance to the 1947 Exhibit Committee as soon as possible.

CHARLESTON JOINT MEETING HEARS SENATOR KILGORE

The Charleston, W. Va., chapters of The Instrument Society of America, The American Chemical Society, The American Institute of Chemical Engineers, The American Society of Civil Engineers, The American Society of Mechanical Engineers and the West Virginia Society of Professional Engineers held a joint meeting on Friday, Sept. 27, to hear Senator Harley M. Kilgore speak on "Federal Science Legislation."

Senator Kilgore, one of the sponsors of the National Science Foundation Bill, which was passed by the Senate but not by the House, spoke on the significance of the proposed Federal Science Legislation and how it would affect the average engineer.

Due to the coincidence of the meeting and the special deadline for this issue, further details of the meeting were not available at this writing.

I.S.A. ELECTS 1946-47 OFFICERS

At the Board of Directors' meeting held on Sunday, Sept. 15, the following officers were elected to serve for the 1946-47 season, and were duly installed at the Annual Meeting of the Society on Thursday, Sept. 19.

President—C. Owen Fairchild, Consulting Engineer, St. Albans, L. I., New York.
First Vice-President—Professor Carl F. Kayan, Dep't. of Mech. Engr., Columbia University, New York, N. Y.
Vice-President—J. B. McMahon, Republic Flow Meters Co., Chicago, Ill.
Vice-President—Dr. R. Munch, Monsanto Chemical Co., St. Louis, Mo.
Vice-President—H. H. Barnum, Consulting Engineer, Detroit, Mich.
Treasurer—Hugh E. Ferguson, Peoples Gas Light & Coke Co., Chicago, Ill.
Executive Secretary—Richard Rimbach, Instruments Publishing Co., Pittsburgh, Pa.

Appointments to the various committees had not been confirmed at this writing except for that of Editor protem for the monthly publication, of which this is the first issue. This assignment has been accepted by R. R. Proctor, The Pure Oil Co., Research & Development Laboratories, Chicago, Ill. Other committee personnel will be announced as soon as possible.

I.S.A. SECTIONS

As of the closing date of the Pittsburgh Conference, Sept. 20, the Instrument Society of America consisted of the following Sections:

Baltimore	New Orleans
California	Northern Indiana
Chicago	Philadelphia
Charleston	Pittsburgh
Cleveland	St. Louis
Cumberland	Tennessee
Detroit	Washington
Gulf Coast	Wayne County
Kansas City	Ontario
New Jersey	Oak Ridge
New York	Southern Michigan

Other individual societies, not yet Sections, include:

The Akron Instrument Society, Akron, Ohio
Georgia Society for Measurement and Control, Atlanta, Ga.
Hartford Society for Measurement and Control, Hartford, Conn.
Houston Instrument Society, Houston, Tex.
Indianapolis Technical Instrument Society, Indianapolis, Ind.
Southern California Meter Association, Los Angeles, Calif.
Sarnia Instrument Association, Ontario, Canada
South Texas Instrument Society, Falfurrias, Texas

The membership list of the I.S.A. as a National Society is still incomplete (Section Secretaries please note), but within the next month or two it is hoped that a complete listing of the Sections with the officers and delegate of each, and the total membership of each Section and of the Society as a whole, can be published.

HIGHLIGHTS OF THE '46 PITTSBURGH CONFERENCE

It was "rumored" around all during the Conference that the Exhibitors were highly pleased with the caliber of the personnel visiting their booths. This rumor was, of course, music to the ears of the committees in charge, according to President Fairchild, and no effort was made to stop it. Dick Rimbach, Executive Secretary, reports that the only "gripe" came from some exhibitors who claimed they were getting "too many customers" and who regretted that they had not taken more space in the Exhibit!

The Conference enjoyed the company of visitors from at least nine countries outside the United States, including government and industry representatives from China, Sweden, Russia, Canada, Great Britain, Czechoslovakia, Switzerland, Australia and India.

Our Past President, Albert F. Sperry, Chicago, has been assigned a new job by his successor, C. O. Fairchild. Al will be the ISA chairman of the 1947 Conference to be held in Chicago next September 8 to 12 inclusive.

It is reported that some of the Conference visitors arriving from the west by air had to deplane at Detroit while both airliner and passengers were given a short breathing spell. It seems that the Chicago-Detroit leg developed into a bronc-busting ride, and mal-de-mer was more common than not among the passengers.

In answer to the questions of some who wondered if the Conference weren't about one day too long, most of the exhibitors reported that they were just as busy on the last afternoon of the show (Friday) as on the other days. In fact, everyone we talked with about both the technical and educational sessions, as well as the exhibit, was very enthusiastic about the entire Conference. We are beginning to wonder, from some of the things we have heard, if Chicago will be big enough for the next one!

Total registration of visitors at the Conference was near the 5000 mark at the last report at noon on the closing day.

More next month.

Other Societies

SOUTHERN CALIFORNIA METER ASSOCIATION

The September meeting of the Southern California Meter Association was held September 19 at the Rio Hondo Country Club, Downey, Calif. James D. Elam, Instrument Engineer at the United States Synthetic Rubber Company, Torrance, Calif., spoke on "Elements of Air Operated Controls." Mr. Elam who has been with United States Rubber plant at various locations across the country is well qualified to speak on the subject. His talk was tersely informative.

A very good turnout was had at the August meeting held on August 15 at which meeting Mr. Fred R. Eaton of the Shell Oil Company presented a paper on Thermocouple and Potentiometer as a means of measuring temperature. The Sheriff Exhition Pistol Team gave an excellent performance with examples of real shooting. Their gun exhibit was very interesting.

—Charles Meriam, *Publicity Chairman*

APPLIED SPECTROSCOPY CONFERENCE AT PITTSBURGH

Each Fall for the past several years an Applied Spectroscopy Conference has been held at the University of Pittsburgh. Now, another is being planned, this time in association with the newly-formed Spectroscopy Society of Pittsburgh. It will probably be held about Nov. 15, 1946. The length of the meeting and the exact program depend to a certain extent upon the response received from you to this notice.

In the past, the program has been built around the requests and the offers of papers by spectroscopists in the Pittsburgh district. This year it is planned to broaden the scope. You are interested in spectroscopy. Do you have any ideas that you would like to have discussed at this meeting or do you have a paper that you would like to present? All suggestions will be carefully considered and an attempt will be made to incorporate them into the program. Ideas from groups of spectroscopists from other cities will be very welcome.

—Mary E. Warga
University of Pittsburgh
Pittsburgh 13, Penna.

INDIANAPOLIS TECHNICAL INSTRUMENT SOCIETY

The Indianapolis Technical Instrument Society opened the 1946-1947 season Tuesday, September 5, 1946, at Purdue University Extension. Mr. W. H. Steinkamp of the Brown Instrument Company gave a very excellent talk on "Pyrometry and the Electronic Potentiometer," discussing the various ways of measuring temperature and giving the fundamentals of each. He also gave a very good description of the "Electronik" potentiometer.

The meeting on October 1st, 1946 was held at the same place and the speaker was Mr. Kermit Fischer of Fischer and Porter Company, his subject "Flow Rate Measurements."

—Morris Underwood, *Secy.-Treas.*

OAK RIDGE INSTRUMENT SOCIETY

The annual business meeting of the Oak Ridge Instrument Society was held in Grove Hall, September 3, 1946. Mr. N. L. Isenhour was elected national representative to attend the National Conference and Exhibit at Pittsburgh.

After the dinner, Mr. L. S. Dysart from Fulton Sylphon Company gave a talk on the manufacture and application of metal bellows. His talk was supplemented by a film "The Story of Metal Bellows." Following the film was a question and answer period in which Mr. Dysart was ably assisted on the technical phase by Mr. C. D. Branson, Fulton engineer. The talk was enlightening to all and especially to some members who were interested in the operation of bellows under severe conditions of loading and vibration.

—A. H. Fowler, *Secretary*

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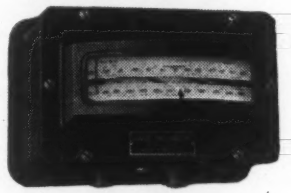

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Unskilled help may handle this direct-deflection instrument, which needs no manual adjustment. Designed for numerous ranges of temperature, both F. and C.

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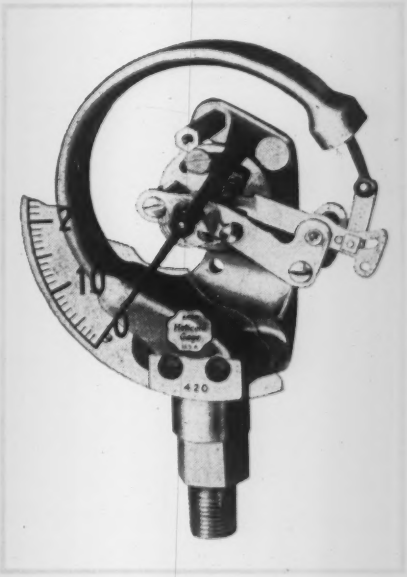

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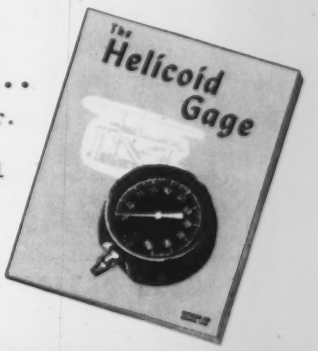

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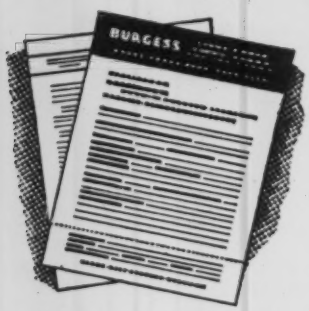

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Manufacturers' New Literature

In this department we report new literature pertaining to Instrumentation, received from the manufacturers. We urge readers to request ONLY those bulletins which will be of value to them. Use the Postage-free Order Card on page 643.

N-393 **Portable Lighting Equipment.** 8-page 8½" × 11" bulletin illustrates and describes "AGA" portable lighting equipment for aviation and marine use: runway lighting sets, mobile floodlighting systems, portable acetylene buoys, illuminated traffic batons, rescue mirrors and the "Agastat" time delay relay. American Gas Accumulator Co., Elizabeth, N. J.

N-394 **Radio Parts, Hardware and Chemicals.** 16-page 8½" × 11" Catalog No. 46 pictures and describes "Walsco" products for radio service men, schools, laboratories and music stores. Walter L. Schott Co., 9306 Santa Monica Blvd., Beverly Hills, Calif.

N-395 **Remote Pressure Transmitter.** 1-page 8½" × 11" catalog sheet pictures and describes maker's pressure transmitter consisting of a sensitive bellows element in a pressure chamber coupled to an ultra-low-torque variable resistor. Instrument provides control or indicating voltage proportional to pressure on bellows element. Autoflight Instruments, 161 East California St., Pasadena 5, Calif.

N-396 **Laboratory Apparatus.** 24-page 8" × 10¾" Catalog No. 46-D pictures line of laboratory equipment and apparatus of exclusive design and manufacture. Eberbach & Son Co., 200 East Liberty St., Ann Arbor, Mich.

N-397 **Electronic Instruments.** 16-page 8½" × 11" catalog supplement (designated as "Postwar Supplement to Catalog C") pictures and describes maker's instruments including, frequency-modulated signal generators, impedance bridges, mica testers and spark coil test sets. Boonton Radio Corp., Boonton, N.J.

N-398 **Adjustable Line Voltage Control.** Single sheet 8½" × 11" pictures and describes "Increvolt" adjustable line voltage control, which can be adjusted to any desired voltage between 0 and 130 volts, accurately, to within 0.1 volt. Unit is protected against burnout due to short circuits or overloads. Sorensen & Co. Inc., 375 Fairfield Ave., Stamford, Conn.

N-399 **Time Controls.** 18-page 8½" × 11" catalog pictures and describes maker's line of time switches, time cycle repeaters, timers and time delay relays and magnetic contactors. Engineering data are included. Paragon Electric Co., 37 West Van Buren St., Chicago, Ill.

N-400 **Relays.** 36-page 8½" × 11" catalog illustrates and describes maker's post-war offerings of relays for every purpose, said to embody engineering refinements developed to the exacting requirements of the armed services. Advance Electric & Relay Co., 1260 West Second St., Los Angeles, Calif.

N-401 **Large Stationary Tachometers.** 8-page 8½" × 11" Bulletin No. 798 pictures and describes maker's centrifugal type tachometers, said to be largest stationary tachometers made in America. Instruments come with 8", 10" and 20" dials and are primarily designed for heavy duty, and to give visibility and readability from a distance on large machines. Herman H. Sticht Co., 27 Park Pl., New York 7, N. Y.

N-402 **Ohmite News.** 2-page 8½" × 11" May issue of this house organ features an article on the life of Samuel Finley Breeze Morse and his accomplishments as an artist and inventor. Included is an interesting column of "Unusual Items" recently developed and several new uses for "Ohmite" rheostats and resistors. Ohmite Manufacturing Co., 4835-41 Flournoy St., Chicago 44, Ill.

N-403 **Input Controller.** 4-page 8½" × 11" Bulletin T-50 illustrates and describes maker's electronic balancer input controller for accurate control of electric furnace temperatures. Unit may be installed in any existing electric furnace temperature control system comprising customary contactor, pyrometer and primary element, regardless of make. Automatic Temperature Control Co., 34 E Logan St., Philadelphia 44, Pa.

N-404 **"Uses Unlimited."** 2-page 8½" × 11" issue of this house organ (designated as Vol. 2, No. 2) contains an article "Theory Behind Serrated Contact Operation" and description of its application in new switches. Included is a column entitled "Column Left" with bits of news and oddities. Micro Switch Div., First Industrial Corp., Freeport, Ill.

N-405 **Miniature Glass Fractionating Pump.** 2-page 8½" × 11" catalog sheet pictures and describes maker's miniature glass two-stage fractionating pump, "Type GF-SA" and glass two-stage booster pump "Type GB-3." Physical data and operation data are included. Distillation Products, Inc., 755 Ridge Road W. Rochester 13, N. Y.

N-406 **Indicating, Recording and Controlling Thermometers.** 32-page 8½" × 11" catalog No. 46 illustrates maker's line of thermometers for industrial and laboratory use. Thermometers are available in mercury, vapor and gas-actuated types for every need. Specifications and engineering data are included. Gotham Instrument Co., 149 Wooster St., New York 12, N. Y.

N-407 **Thermocouples.** 16-page 8½" × 11" catalog No. 4 illustrates and describes maker's thermocouples, thermocouple wires, thermocouple lead wires, protection tubes, insulators, terminal heads, connectors and other accessories. Arklay S. Richards Co., Inc., 52 Winchester St., Newton Highlands 61, Mass.

N-408 **Aircraft Instrument Test Table.** 2-page 8½" × 11" catalog sheet illustrates and describes "Model 1406R" instrument testing table for all types of gyro aircraft instruments. Table has combined motions of roll, pitch and yaw infinitely adjustable from 0° to 15° angle. Ideal Laboratory Tool & Supply Co., Cheyenne, Wyoming.

N-409 **Specific Gravity Indicator.** Single sheet 8½" × 11" pictures and describes "SK Specific Gravity Indicator," which provides continuous indication of specific gravity by means of a standard hydrometer. Instrument is readily installed in new or existing pipe lines and was adapted from the "SK" universal rotameter with which most parts are interchangeable. Schutte & Koerting Co., 12th & Thompson St., Philadelphia 22, Pa.

N-410 **Solenoid Valve.** 4-page 8½" × 11" Bulletin No. 461 illustrates and describes

"Model V5-200" two-way normally-closed solenoid valve, built for use with CO_2, air, water, hydraulic fluids and other media. Valve is smaller than ordinary valves of equal capacity, media contacting surfaces are of stainless steel and leaks are eliminated by use of soft seats. Allied Control Valve Co., Inc., South Norwalk, Conn.

N-411 **Engine Safety Control.** 2-page 8½" × 11" Data Sheet W-1 illustrates and describes "Viking Safety Control Type W-1" alarm system for boat and truck engine cooling water temperatures and oil pressures. Unit consists of indicator, temperature control and buzzer. Viking Instruments, Inc., Stamford, Conn.

N-412 **"Aminco Laboratory News".** 12-page 8½" × 11" issue of this house organ (designated as Vol. 3, No. 3) is devoted to application of scientific instruments to modern laboratory technique, engineering, materials testing and production control. This issue features bits of technical news and a section on "New Inventions & Discoveries." American Instrument Co., 8030-8050 Georgia Ave., Silver Spring, Md.

N-413 **Engine Hour Meters.** 2-page 8½" × 11" catalog sheet Ex-526 pictures and describes maker's aircraft type engine hour meters, also for use in laboratories or in testing work, for indicating hours and accumulated number of hours of operation. A sensitive electric brake enables indicating engine operation hours to the second. John W. Hobb Corporation, Springfield, Ill.

N-414 **Radio Compass.** 8-page 8½" × 11" bulletin illustrates and describes maker's automatic radio compass, which gives continuous, accurate, direct indications of the relative bearing of any radio station tuned in on its sensitive receiver and crossbearings may be quickly taken to check exact position of airplane. Bendix Radio Div., Bendix Aviation Corp., Baltimore 4, Md.

N-415 **Dual Temperature Soldering Iron.** 2-page 8½" × 11" bulletin illustrates and describes maker's controlled temperature "Dual-Heat" soldering irons. Iron works at regular temperature for ordinary soldering job and easily doubles its heat output when button on shielded handle is pressed, permitting heavy soldering and tin smithing. Dual-Heat Iron Co., 4370 Sunset Blvd., Los Angeles 27, Calif.

N-416 **Remote Positioning Control.** 4-page 8½" × 11" bulletin pictures and describes "Flectrol" remote positioning control, a flexible electrical remote control system adaptable to speed changing equipment, motor-operated valves and machine tools. Unit remotely controls the rotation of a small motor used to adjust pulleys or gears of speed changers. Yardeney Engineering Co., 105-107 Chambers St., New York 7, N. Y.

N-417 **Precision Mensuring Instruments.** 4-page 8½" × 11" bulletin illustrates and describes "Amic comparator" for quick checking of components in tool room or production line without eye fatigue. Scale is direct reading in 0.0001" divisions; measuring pin displacement of 0.001" causes hand to move one full inch. Included is "Amic Opto-Indicator" a precision indicating gage of the optical-lever type. American Measuring Instruments Corp., 240 W. 40th St., New York, N. Y.

N-418 **3-Dimensional Drawing.** 4-page 8½" × 11" bulletin illustrates and describes "Pomeroy Stereograph" drawing machine for precision drawing of Stereograph diagrams. Instrument permits analyzing and viewing inanimate objects superimposed in space, constructing and drawing hyperbolas, parabolas, vectors, space and force curves. Pomeroy Stereograph Co., Inc., Empire Bldg., 178¾ East 11th St., Cleveland 14, Ohio.

N-419 **Electronic Resistance Thermometer.** 12-page 7¾" × 10½" Bulletin 230-A illustrates and describes "Pyrotron" re-

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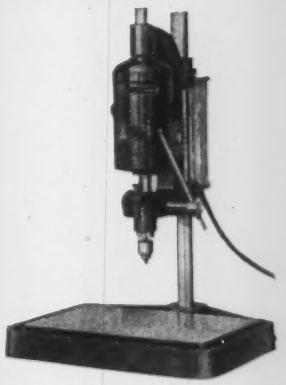

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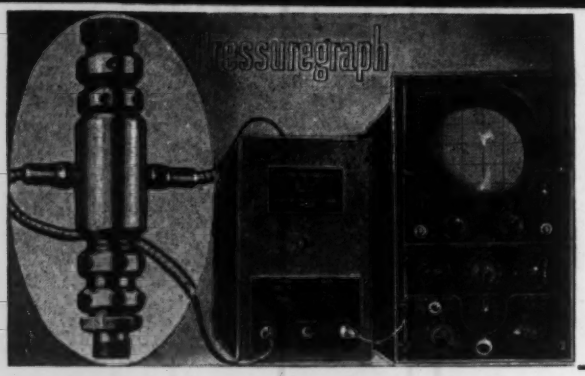

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corder, an electronic resistance thermometer which records four temperatures continuously on moving chart. Instrument is suitable for all classes of severe service. Bulletin also describes installations and accessories. Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland 10, Ohio.

N-420 **Pyrometer Supplies.** 40-page 8" × 10½" Catalog & Buyers' Guide No. 100-1 illustrates and describes maker's thermocouples, protecting tubes, thermocouple wire, leadwire & insulators. Catalog presents clear and concise information to purchasing agents and instrument men on how to order pyrometric supplies. Brown Instrument Co., Accessories & Supplies Div., Philadelphia 44, Pa.

N-421 **Gas Content Indicator.** 4-page 8½" × 11" Bulletin 3869 pictures and describes "Deoxo" indicator for the detection and continuous measurement of traces of oxygen and hydrogen in gases. When required, indicator can be furnished with a circular or strip chart type potentiometer-recorder and controller. Baker & Co., Inc., 113 Astor St., Newark 5, N. J.

N-422 **Elements of Facsimile Communications.** 16-page 5½" × 8½" booklet, for the layman, describes in non-technical language the theory and operation of equipment for the transmission and recording of photographs, drawings, maps and text by facsimile over wire or radio channels. Complex electronic and mechanical operations are illustrated by simple analogous diagrams. Times Telephoto Equipment Inc., 229 W. 43rd St., New York 18, N. Y.

N-423 **Facsimile Communications Equipment.** 14-page 5½" × 8½" booklet describes transmitting and recording equipment for the transmission and reception of photographs, drawings or text over wire or radio circuits. The required characteristics of the circuit are specified. Description and specifications are given for three types of equipment: a transmitter for 7" × 8" copy, a recorder to receive copy from this transmitter, and a transceiver for 12" × 18½" copy. Recorder and transceiver will record a positive or a negative of the original on photographic paper or film, or directly on special recording paper which does not require photographic processing. Times Telephoto Equipment Inc., 229 W. 43rd St., New York 18, N. Y.

N-424 **Components for Facsimile Communications Equipment.** 14-page 5½" × 8½" booklet describes special components of facsimile equipment. Their characteristics and precision render them useful in the laboratory and for instrument applications. Included are "Recorder Optical Systems," "Transmitter Optical Systems," "Tuning Fork-Controlled Constant Frequency Audio Oscillators" and "Synchronous Motors" for operation on 250-4000 cps. Specifications and prices are included. Times Telephoto Equipment Inc., 229 W. 43rd St., New York 18, N. Y.

N-422a **Precision Tools.** 4-page 6" × 9" Circular B illustrates and describes three of maker's line of precision tools; (1) precision hand tapping unit, accurate for class 4 threads, (2) toolmakers surface gage, and (3) steel beam trammel. Precise Instrument Co., 200 Tillary St., Brooklyn 1, N. Y.

N-423a **Electronic Interval Timer.** Single sheet, 8½" × 11" illustrates and describes "Model 1029" electronic interval timer for applications requiring highly accurate circuit timing. Time range is from 1 to 120 seconds in increments of one second. For 115-volt 60-cycle operation only. Electronic Controls, Inc., 44 Summer Ave., Newark 4, N. J.

N-424a **Operation Recorder.** 4-page Booklet N illustrates and describes "Servis Recorder" operated by any mechanical motion. Instrument records operation on clockwork-driven 24-hour chart and tells machine "idle time" at a glance. Service Recorder Co., 1375 Euclid Ave., Cleveland, Ohio.

N-425 **Bench-Type Electric Furnaces.** 4-page 8½" × 11" Bulletin No. 56 illustrates and describes "Types MH-3 and MH-4" muffle furnaces suitable for tools, dies, and varied small parts heat treating. Unit holds 1600°F. with 2 kw. Cooley Electric Manufacturing Corp., 42 So. Shelby St., Indianapolis, Ind.

N-426 **Electronic Volt-ohmmeter.** 2-page 8½" × 11" bulletin illustrates and describes "Model 406" volt-ohmmeter with bridge-type circuit—fully balanced through 3 stages, for maximum accuracy and stability. Unit measures every d.c., a.f., i.f., r.f., and u.h.f. potential with full scale sensitivity from 1 to 1000 volts. Clippard Instrument Laboratory, Inc., 1440 Chase Ave., Cincinnati 23, Ohio.

N-427 **Supervisory Control System.** 8-page 8½" × 11" Bulletin No. AA1 illustrates and describes "Super-Trol" system for remotely controlling operations of substations and hydro-plants. Controller panel board indicates opening and closing of breakers, generator operation and controls these operations several miles away by manual or automatically-operated switches. Control Corp., 718 Central Ave., Minneapolis 14, Minn.

N-428 **Dial Indicators.** 56-page 8½" × 11" Third Edition catalog illustrates and describes maker's line of dial indicators for all types of precision measurements from heavy production checking to precise laboratory control. All instruments furnished in accordance with American Gage Design Committee Specifications. L. S. Starrett Co., Athol, Mass.

N-429 **Pyrometer Controller.** 4-page 8½" × 11" Bulletin No. D4-2 illustrates and describes "Multronic Capacitrol," a multi-position pyrometer controller for on-off control of electric, oil- or gas-fired equipment. Unit capable of multi-signaling at two points and provides automatic fuel shut off. Wheelco Instruments Co., 847 W. Harrison St., Chicago 7, Ill.

N-430 **Frequency Meter.** 2-page 8½" × 11" Bulletin 6493 illustrates and describes "Model S-4" frequency meter, designed for checking frequencies of police, fire department, marine, and other special-service transmitters. Browning Laboratories, Inc., Winchester, Mass.

N-431 **Screw-thread Gages.** 56-page catalog illustrates and describes gages for inspection and quality control of male screw threads. Group consists of snap gages, screw-thread lead tester and comparator, ring-snap gages and taper gages. Johnson Gage Co., Bloomfield, Conn.

N-432 **"Gauss Meter."** 2-page 8" × 10½" Bulletin GEA-4545 illustrates and describes "GE gauss meter," a miniature magnetometer designed for ready measurement of the density and direction of flux in permanent magnets and d-c. electromagnets. General Electric Co., Schenectady, N. Y.

N-433 **Dynamic Balancing.** 4-page 8½" × 11" Bulletin No. IB-5 illustrates and describes line of dynamic balancing machines for balancing rotating parts—from tiny armatures to huge turbine wheels. Bear Manufacturing Co., Industrial Div., Rock Island, Ill.

N-434 **Ceramic Capacitors.** 2-page 8½" × 11" Bulletin No. 933 illustrates and describes "BC" by-pass and coupling ceramic capacitors. This bulletin is first of a series of temporary bulletins designed to bring pertinent information as quickly as possible to the radio manufacturing industry. Centralab Div., Globe-

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Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

N-435 **Sub-zero Units.** 4-page 8½" × 11" bulletin illustrates and describes "Kold-Hold" industrial sub-zero refrigeration units. Units operate within a temperature of ambient to —45°F., and ambient to —60°F. and are available in 2 and 4 cubic foot sizes. Bowser, Inc., Refrigeration Div., Terryville, Conn.

N-436 **Thermal Conductivity Cells.** 2-page 8½" × 11" Bulletin No. 41546 illustrates and describes "Ever-Tite" thermal conductivity cells for gases. Units are for use with standard potentiometers, recorders or galvanometers wherever laboratory techniques make desirable the observation of gases by thermal conductivity methods. Gow-Mac Instrument Co., 22 Lawrence St., Newark 5, N. J.

N-437 **"Aerovox Research Worker."** 4-page 8½" × 11" issue of this house organ (designated as Vol. 18, No. 5) contains Part 3 of the "V.H.F. Primer" entitled "Wave Guides." Also illustrated is maker's "Rating-plus" capacitors for radio, electronic and industrial application. Aerovox Corp., New Bedford, Mass.

N-438 **"The Laboratory."** 30-page 6" × 9" issue of this house organ (designated as Vol. 16, No. 1) features an article "Science Contributes Streptomycin" on the new antibiotic said to be the first specific found which kills the tularemia bacteria. Remainder of this issue is devoted to new products of this laboratory supply house. Fisher Scientific Co., 717 Forbes St., Pittsburgh, Pa.

N-439 **Volt-milli-ammeter.** 4-page 9" × 12" Bulletin No. 105 illustrates and describes a laboratory instrument that will meet the volt-ampere test requirements of practically any circuit where current or potential values are between 0.002 to 1000 volts and 20 microamps to 10 amperes. Calibrated shunts and multipliers manually inserted for range shift. Reiner Electronics Co., Inc., 152 W. 25th St., New York 1, N. Y.

N-440 **Electric Tachometer Generator.** 6-page 8½" × 11" bulletin illustrates and describes "Compak" electric tachometer generators which are about half size and weight of "standard" tachometer generators. Unit designed to operate single tachometer indicator per engine. Kollsman Instrument Div., Square D Co., Elmhurst, N. Y

N-441 **"Weston Engineering Notes."** 8-page 8½" × 11" June issue of this house organ (designated as Vol. 1, No. 3) contains three articles (1) Westons Cadmium Cell, (2) Vacuum Type Thermoelement, and (3) Simplified Bridge Analysis. Weston Electrical Instrument Corp., 614 Frelinghuysen Ave., Newark 5, N. J.

N-442 **Gage Blocks.** 6-page 3½" × 8½" Bulletin 7393-1 illustrates and describes maker's gage blocks and accessories. Unit described is "Set No. 1" comprised of 81 blocks which, when used singly and in combination, make more than 120,000 different size gages, in steps of 0.0001 inch Johansson Div., Ford Motor Co., Dearborn, Mich.

N-443 **Capacitors and Filterettes.** 40-page 8½" × 11" 1946 catalog illustrates and describes line of capacitors and makers "Filterettes," radio noise-suppression units. Catalog is an up-to-date compilation of structural data and performance characteristics of capacitors having widely diversified application in the production of electrical apparatus. Tobe Deutschmann Corp., Canton, Mass.

N-444 **Relays and Control Devices.** 4-page 8½" × 11" bulletin illustrates and describes "Aemco" relays and control devices for electronic, radio, telephone, signals, and electro-medical applications. Automatic Electric Manufacturing Co., Mankato, Minn.

N-445 **Water Level Control.** 4-page 8½" × 11" Bulletin No. 455 illustrates and describes the use of "Copes Flow-matic Regulator" for controlling water

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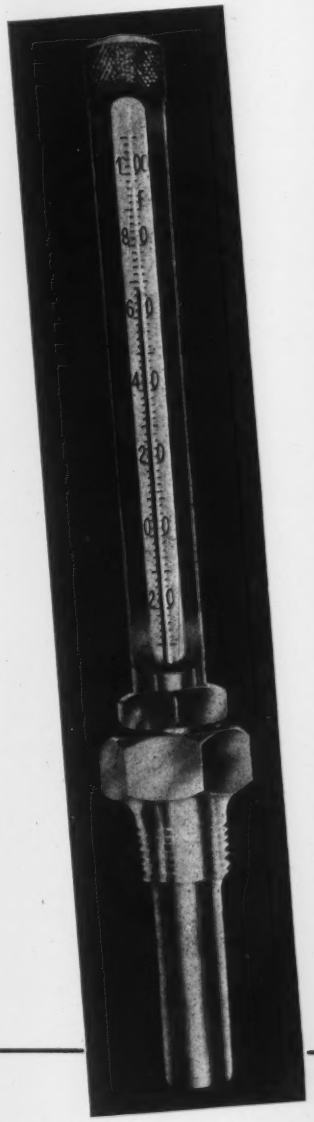

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